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SHARPLES (A.). **Preliminary and detailed reports on 'black fruit' disease of Pepper vines in Sarawak.**—*Govt. Print. Office, Kuching, Sarawak*, 15 pp., 1922.

This pamphlet contains a brief preliminary report on a serious disease of *Piper nigrum*, which the writer was invited to investigate by the Rajah of Sarawak, followed by a more detailed account of the state of pepper cultivation in Sarawak and the general characters of the disease. The latter is regarded as being primarily due to the attacks of the alga *Cephaleuros mycoidea*, already known to cause serious diseases of tea and cloves, and less fully studied diseases of several other cultivated plants.

On pepper, the alga is practically confined to the fruit. It is difficult to find any trace of it on young vines up to the time of flowering (1½ to 2 years), and even after the fruit disease is well established the organism is seldom found on the leaves and stems, although in one case the petioles were attacked. After the berries form, those at the free end of the spike turn black, shrivel, and may fall off. At the same time the remaining, practically ripe berries show small, black spots from which arise the fruiting stalks of *Cephaleuros*. In the final stage all the berries are involved; most fall to the ground, but a few remain in a mummified condition attached to the blackened spike. From these mummies a strong growth of the alga can be obtained under suitable conditions. The writer is strongly inclined to the view that *C. mycoidea* is responsible for the whole of the symptoms observed.

The damage caused by this disease is very severe, and it has been one of the main causes of the serious fall in the pepper exports for Sarawak within the past ten or fifteen years. For its control spraying does not seem a promising line of attack on account of local difficulties. Much of the trouble is due to the system of abandoning the pepper gardens after a time and moving to a new area, leaving the abandoned plants a prey to parasites and a menace to other gardens in the vicinity. Measures to check this practice, and also to enforce removal of the old plants when it cannot be

prevented, are strongly recommended. The absence of any machinery to ensure that the gardens are properly cared for is emphasized, and the need for some form of agricultural organization in the State pointed out.

FAWCETT (G. L.). **Enfermedades de la Caña de Azúcar en Tucumán.** [Diseases of Sugar-cane in Tucumán.]—*Rev. Indust. y Agric. de Tucumán*, xiii, 1–2, pp. 1–46, 21 figs., 1922.

In this paper the chief diseases affecting sugar-cane in the province of Tucumán, Argentina, are described and an account is given of the author's own researches in regard to them.

Top rot or 'polvillo' affects chiefly plant-cane, the proportion of which to the whole crop is small. Reddish stains appear on the sheaths, and streaks of the same colour on the leaves. Later the two or three most recently formed leaves dry up and the apical shoot can be easily pulled out. The interior leaves and sheaths are rotten and surrounded by a thickish, evil-smelling liquid. At times the pressure of the growing apical shoot ruptures the sheaths where they are weakened by putrefaction, and the shoot may then emerge laterally. This condition, which is known in Java as 'pokkah bong', occurs in cases where the sheaths are attacked while the growing shoot is not yet affected. Usually the latter is ultimately involved in the rot.

The early stages of the disease are marked by the appearance of small translucent spots in the cylinder formed by the sheaths in the apical bud. The spots may be only a few millimetres in diameter and are covered with a watery exudation. Three bacteria were isolated from such spots and named *Bacillus flavidus* n. sp., *Bacillus D*, and *Bacillus F*, respectively. All three are motile, with peritrichous cilia, liquefy gelatine, and form acids on media containing sugar. *Bacillus D* is Gram positive and generates no gas on media containing sugar, while the others are Gram negative and produce gas. Their other characters are tabulated and described. Inoculations proved that all were capable of producing top rot, *B. flavidus* being the most virulent. A high temperature is necessary for successful infection, no success being obtained from inoculations during the cool season (March–April). Rapidly growing cane is usually immune. Infection ordinarily results from bacteria lodged with dust in the apical bud of the cane outside the last three leaves to be formed, where the spaces usually hold water and give organisms every chance to multiply.

Susceptible varieties include plant-cane of 213 POJ, plant-cane and ratoons of 234 POJ, and a few other less important varieties. Kavangire and 36 POJ are considered resistant, though the latter may be attacked during its first year of growth. With regard to the disease known as top rot in Java, the author thinks that several different affections are included. No mention has been made there of a reddish discoloration on the leaves, and the author is of the opinion that the Argentine disease is distinct. *Bacillus vasculorum*, to which top rot as well as gummosis has been attributed by some writers, has not been found in Tucumán. Mosaic probably predisposes the plants to 'polvillo' but chlorosis is not a normal symptom of the latter, as stated by Spegazzini. Methods of cultivation and irrigation have no influence on the disease.

Sugar-cane mosaic is common in the province but the affected Javanese canes give good yields. Thick canes seem to suffer more than thin, but the former are believed to be, in any case, unsuited to the Argentine climate which is sub-tropical. The so-called Japanese canes, Kavangire, Zwinga, and Yon Tan San, are immune but give too little sugar to be of value, while of the Java varieties 36 POJ is the most resistant and 213 POJ the least. Of other varieties, D 1135 is almost as resistant as the Java canes. The author reports having received cane affected with mosaic from Brazil, though the disease does not appear to have been recorded in that country as yet. In Tucumán it is impossible to find a cane quite free from mosaic, amongst the commonly cultivated kinds. Indications point to insect transmission of the infection, but the species concerned has not yet been found. Aphids are not believed to be responsible, at least not the species which the author has found on diseased canes and which is believed to be *A. sacchari*. Attempts to secure infection by juice inoculations failed, except when carried out on the young leaves before they had emerged from the bud, in which case 15 out of 21 in three different series were successful.

In experiments on the control of the disease it was found that neither fertilizers nor cultivation had any influence on it. Roguing was also of no value, which is not surprising in view of the universal prevalence of infection. On the other hand, careful selection of seed cane is stated to have given good results.

Rotting of sugar-cane setts after planting is a trouble characteristic of sub-tropical countries, where the low temperatures after planting may delay germination. Partially rotted setts may germinate, but the shoots remain more or less stunted. Varieties differ greatly in their liability to rot; Criolla, for instance, is susceptible, especially the white strain, which usually dies out from this cause in a few years, while the purple strain of this variety is less liable to rot. The common Javanese varieties originally introduced are very resistant, except 100 POJ and 139 POJ; Kavangire and its allies are also resistant, but all the other varieties grown are susceptible. Every year the gaps left by failure to germinate have to be replanted in the case of the susceptible varieties, or the variety would ultimately die out. In damp or badly-drained soils, especially where nitre is present, even the resistant varieties suffer from rot. Mosaic predisposes to this trouble in a marked degree.

Amongst the numerous fungi and bacteria isolated from rotted setts, a list of which is given, the most virulent were found to be *Acrostalagmus glaucus* n. sp., *Cytospora sacchari*, *Melanconium sacchari*, and a species of *Fusarium*. Several others, including *Acrostalagmus sacchari* n. sp. and some bacteria, can cause a certain amount of damage.

Of frequent occurrence in the spring is a disease called 'yellows', in which the young shoots turn yellow or whitish. It is usually the result of the sett rot described above, and is associated with a scanty development of the roots. Similar conditions arise from drought, and the presence of nitre in the soil. Sulphate of ammonia counteracts the latter to a certain extent, but the use of resistant varieties is the best preventive. The practice of 'windrowing'

is stated to be productive of sett rot and yellows. Burning the trash on the fields as soon as possible after cutting the cane has been shown by experiment to reduce the damage.

Melanconium sacchari has been said to cause a rind disease of little importance in Tucumán. It is frequently associated in other countries with the much more destructive red rot due to *Colletotrichum falcatum*, and the author thinks that the latter is the usual primary cause of rind disease as described elsewhere, though *M. sacchari* may sometimes directly attack enfeebled canes.

The ring spot due to *Leptosphaeria sacchari* appears to be of recent introduction into Tucumán. Mosaic predisposes to the attacks of this fungus, which does little harm, as it is usually confined to the older leaves of the thick varieties. The species described under the same name by Spegazzini differs from that here referred to in not causing spots and in other characters. A *Phyllosticta* occurs on the same spots as the perithecial fungus, and is believed by the author to be genetically related to the latter [see also this *Review*, i, p. 271].

A linear leaf spot is caused by *Phyllosticta sacchari* Speg., but is not very common. It is restricted to chlorotic leaves and those affected with mosaic, and is found at times on the large white or yellow stripes which are characteristic of the broad leaves of Criolla and other thick canes. These stripes are thought to be identical with those described by Cobb as due to the attacks of *Mycosphaerella striatiformans*, a fungus not known in Tucumán. *P. sacchari* does very little damage, and appears to be found only in the Argentine.

Root disease of the type usually attributed to the attacks of *Marasmius sacchari* is present in Tucumán to a small extent. The disease causes a rot of the young roots, which are at first marked with red spots, then turn black, and later break down and decay. The rot spreads along the roots to the old seed-piece from which they have arisen. Affected clumps are malformed and stunted, and owing to the destruction of a great part of the root system they readily succumb to unfavourable conditions such as drought. The author doubts whether *Marasmius sacchari*, or the species of *Rhizoctonia* and *Pythium* to which the disease has been more recently attributed [see this *Review*, i, pp. 102, 205, 313] are really the primary cause of the rot; he thinks the latter is due more to defective soil conditions such as a bad soil texture or water-logging. He has observed that cane suffers from the disease in some of the badly-drained soils in the south of the province in seasons of excessive rainfall. Elsewhere it is not common. *M. sacchari* has not been found in Tucumán, though two saprophytic fungi rather like it, *Naucoria suborbiculata* and *Omphalia saccharicola*, have been observed on the dead sheaths and bases of the clumps.

Amongst the common diseases of sugar-cane known in other countries but not yet reported in Tucumán may be mentioned pine-apple disease (*Thielaviopsis paradoxa*), red-rot (*Colletotrichum falcatum*), and gummosis (*Bacillus vascularum*). These diseases are briefly described, as well as some others of more restricted distribution. Latin diagnoses, with figures, are given of the new species *Acrostalagmus glaucus* and *A. sacchari*, and the *Fusarium* found to be one of the causes of sett rot is briefly described.

GÄUMANN (E.). **Ueber die Gattung Kordyana Rac.** [The genus *Kordyana* Rac.]—*Ann. Mycol.*, xx, 5–6, pp. 257–271, 7 figs., 1922.

Raciborski founded the genus *Kordyana* in 1900 with the following characters. 'Parasitic fungi, related to *Exobasidium* and *Microstroma*, with small, hemispherical hymenia protruding from a small stroma in a stomatal cavity. The non-septate basidia each bear on the apex two sterigmata with oblong elliptical, hyaline, smooth spores'. Of the two original species, the author transfers one (*K. pinangae*) to a new genus, and to the other (*K. tradescantiae*) he adds two new species, *K. celebensis* and *K. polliae*. The host plants of all three are members of the Commelinaceae. As revised the genus consists of parasitic Autobasidiomycetes, which protrude from stomatal cavities, have a limited hymenium, and form more or less hyaline and smooth spores. It resembles *Exobasidium* in its parasitic habit, its white or yellow hymenium, the longitudinal division of its basidial nuclei (stichobasidial type), the variability in number of basidiospores, to some extent in its formation of paraphyses, and in the sporidia germinating sometimes by budding. It differs morphologically in its hypha-shaped basidia (which cannot be recognized as such till the sterigmata and spores appear), their inequality in height, the successive abstriction of spores, and in the fact that the spores do not become uniseptate on germination. It further differs in its restriction to one monocotyledonous family of host plants, its more virulent parasitism, and in the fact that it is dependent on the stomatal cavities of the host for the formation of its fruiting bodies. The author considers that *Kordyana* represents a primitive genus of the family Exobasidiaceae.

The author makes Raciborski's other species the type of his new genus *Brachybasidium*, as *B. pinangae* (Rac.) Gäum. on *Pinanga kuhlii*. This genus is held to differ from *Kordyana* fundamentally in the transverse division of its diploid nuclei (chiastobasidial type), and further in that the basidia are borne on specialized subterminal cells, which the author considers to be homologous with the teleutospores of the Protobasidiomycetes, in which case the apparent hymenium must be considered as a teleutospore sorus. He considers his new genus as the most highly evolved member of Maire's Tulasnellaceae-Vuilleminiaceae group.

The hymenium of *Kordyana celebensis* on *Commelina benghalensis* is often invaded by a fungus belonging to the Mucedineae which is probably parasitic on the *Kordyana*. Its conidia are bicellular and provided at the free end with a single cilium. This fungus is named *Monotrichum commelinae* n. g., n. sp.

BUCHHEIM (A.). **Zur Biologie von Uromyces pisi (Pers.) Winter. Vorläufige Mitteilung.** [On the biology of *Uromyces pisi* (Pers.) Winter. Preliminary note.]—*Centralbl. für Bakt.*, Ab. 2, lv, 21–24, pp. 507–508, 1922.

The author has studied the specialization of *Uromyces pisi* on different hosts in Moscow. Uredospores from *Lathyrus pratensis* infected *Pisum arvense*, *P. sativum*, *Lathyrus nissolia*, and *L. articulatus*, but failed to infect *Vicia sativa* and two other species of *Vicia* tested. The identity of the fungus on *Lathyrus* and *Pisum*, established by Jordi in 1904, was thus confirmed.

VAN LUYK (A.). **Ueber einige Sphaeropsideae und Melanconieae auf Nadelhölzern.** [Notes on some Sphaeropsideae and Melanconieae on Conifers.]—*Ann. Mycol.*, xxi, 1–2, pp. 133–142, 1923.

The various species of *Sclerophoma* described on different coniferous trees are discussed, and the conclusion reached that only a single genuine species of this genus has hitherto been recorded on conifers, namely, *S. pityophila* (Cda) v. H. *S. pityа* v. H. and *S. pityella* Died. are merely forms of this fungus found on the larch, and *S. piceae*, a form on the spruce. *S. pini* v. H. is not a *Sclerophoma* but *Rhizosphaera kalkhoffii* Bub. Grove's suggestion that *S. pityа* may be identical with his *Phomopsis abietina* [see this *Review*, i, p. 92] is regarded as requiring further testing by cultural methods.

Notes are given on a number of species of *Phoma* recorded from conifers, and also on several Melanconiaceae. *Glocosporium pini* Oud. is stated to be identical with *Leptostroma pinastri*, and the latter fungus, together with *L. laricinum*, are regarded as belonging to the Melanconiaceae. *Aposphaeria pinea* Sacc. is said to be based on a misunderstanding of the fructifications, which really belong to *Ceratostomella pini* Münch, while *Sphaeronema pilifera* is also apparently *Ceratostomella*.

KEISSLER (K.). **Revision einiger von Fautrey aufgestellter Pilze.** [Revision of some of Fautrey's fungi.]—*Ann. Mycol.*, xxi, 1–2, pp. 70–83, 1923.

Under *Ascochyta cucumis* Fautr. & Roum. [pp. 74–75] the author expresses his belief that there can be little doubt that *A. citrullina* C. O. Smith [the imperfect stage of *Mycosphaerella citrullina* (C. O. Sm.) Grossenb.] and *A. melonis* A. Potebn. are identical with Fautrey's fungus, which antedates the others. He suggests also that *Macrophoma decorticans* All. and possibly *M. cucurbitacearum* Trav. & Migl. belong to the same species. It does not appear, however, that authentic specimens of these fungi have been examined by the author.

Cercospora fabae Fautr. on *Vicia faba* is thought to be very near *C. rautensis* Mass. on *Coronilla*. *C. columnaris* Ell. & Ev. is regarded as an *Isariopsis*, and synonymous with *I. griseola* Sacc. *C. phaseolorum* Cke is, however, considered to be a true *Cercospora* and, therefore, not allied to Ellis and Everhart's fungus as the latter thought.

VAN DER BIJL (P. A.). **A contribution to our knowledge of the Polyporeae of South Africa.**—*South African Journ. of Science*, xviii, 3–4, pp. 246–293, 1922.

This is an account, with technical descriptions in English, of all the species of the sub-family Polyporeae known to occur in South Africa: the sub-families Boleteae and Meruleae are not dealt with. Keys to the genera and species are included, and of the latter nine are new. The author stresses the importance of the study of this

group in a country with large forest areas, as its parasitic members reduce the annual rate of wood production, and its saprophytes destroy wood already formed.

TUNSTALL (A. C.). **Notes on some fungus diseases prevalent during season of 1922.**—*Quart. Journ. Sci. Dept. Indian Tea Assoc.*, iii, 115–123, 1922.

Of the fungi causing root disease of tea prevalent in northern India only one, *Hymenochaete noxia* [*Fomes lamaoensis*] produces no spores on this host. This disease is, therefore, always the result of contact infection, usually spreading from root to root below ground but sometimes along trenches in which woody material has been buried. It usually originates in the dead roots of jungle trees and is especially prevalent on sandy soil. No soil treatment, however, appears to be effective. Complete removal of all dead and infected wood (roots, &c.) is the only reliable method of control.

Ustulina zonata not only spreads from root to root but is also transmitted above ground by means of spores, which cause infection of the plants through decaying wounds, such as dead snags or borer holes. The disease occurs principally on acid soils, and may be controlled to some extent by the application of heavy lime dressings to counteract the acidity. All dead snags should be removed and the wounds painted with 5 lb. copper sulphate in 10 galls. of rice water to which sufficient slaked lime has been added to make a paste. *Kretzschmaria micropus* resembles *U. zonata* in symptoms and effects.

On some deteriorated bheels the tea has become infected with the Jew's ear fungus, *Auricularia* [*A. auricula-judae*], which enters the plant through dead snags, penetrates the woody tissue and the growing layers, and finally destroys the bush branch by branch. The treatment recommended for the control of *U. zonata* is also applicable to this disease.

Sphaerostilbe repens spreads similarly to *U. zonata*, but is more readily controlled by heavy liming and improved drainage. The disease is confined to water-logged, acid soils, and even badly infected bushes recover with suitable treatment. Stiff soils, difficult to drain, are generally infected with this fungus.

Rosellinia arcuata is distributed by spores and by spreading along dead organic matter from bush to bush. It generally originates in decaying snags or collections of dead leaves lying in contact with the bushes. It also grows in dead wood buried in trenches. In most cases liming the soil and exposure of the collars of bushes adjacent to the infected plants will check the spread of the disease. In order to avoid the long and tedious work of digging out all the diseased material from infected trenches, the trenching material should be sprinkled with lime before covering, if there there is any reason to suspect the presence of the fungus. The continuity of the trenches should also be broken at intervals.

Thyridaria tarda [*Botryodiplodia theobromae*] is probably the most widely distributed root fungus in the tea districts of north-eastern India but causes serious damage only in exceptional circumstances, as, for instance, after a protracted spell of severe drought, which diminishes the vitality of the plants. In some

cases sudden death from the attacks of this fungus occurs after pruning. The fungus is most prevalent on coarse, sandy soils, and infection is most often found when the wood is drying back from the cut ends of branches. The latter should be protected by painting with the mixture recommended under *U. zonata*, while the application to the soil surrounding each bush of 2 to 3 oz. of nitrate of potash has also been found very beneficial in stimulating the development of the plants. All heavy pruning on the soils liable to induce the disease should be done very early, as it has been observed that there are fewer *Botryodiplodia* spores about in September and October. Root attacks are also found, chiefly when the roots have been injured during cultivation. Infected bushes frequently exhibit a moribund condition and are liable to attack by various leaf blights, especially in the case of unpruned or lightly pruned tea. Spraying with lime-sulphur in April is recommended in such cases.

Root diseases spread mainly underground and any dead wood in the soil, is liable to act as a centre of infection. No woody tree appears to be immune from root diseases of one kind or another and it is useless to attempt to compile a list of trees, the stumps of which may serve to start such diseases. The burying of infected material in trenches is also a fruitful source of trouble, unless accompanied by sprinkling with lime. In the case of fungi which are able to spread above ground, decaying snags are the principal points of infection and should be removed. The enormous losses due to root diseases can be greatly minimized by timely precautions, and except *Botryodiplodia* they can usually be controlled by careful removal of the infected bushes immediately the attack becomes visible.

Black rot (*Hypochnus theae*) has recently caused considerable damage in Assam. The fungus attacks the green shoots and leaves, covering them with an exceedingly fine mycelium, the hyphae of which are almost indistinguishable even under a microscope. The first symptom of the disease is a slight discoloration of the leaf which rapidly becomes darker. On drying, the patches resemble those caused by brown blight [*Glomerella cingulata*], which, together with grey blight [*Pestalozzia theae*], is frequently present as a secondary invader and helps to obscure the true nature of the disease. Infected leaves adhere to each other wherever they are brought into contact. In many cases the disease occurs in patches on the bushes, unlike brown blight which is distributed all over the plant. The basidiospores which are produced on the ends of hyphae projecting from the mycelial net, are sprinkled over white patches situated on healthy-looking, green portions of the under sides of the leaves. The disease, however, is disseminated more by contact than by spores, as the spore patches are scanty. During the period of actual production of the spores the spread of the disease is much more rapid than at other times and infected bushes may be found distributed throughout an entire section.

Owing to an incorrect diagnosis of the symptoms, the presence of black rot in one case reported was not detected until very severe and extensive damage had been caused. Suspected areas should be isolated immediately and cultivated by a special gang of coolies

who, with their implements, &c., should be sprayed (care being taken to avoid the face) with lime-sulphur on leaving their work. All diseased material should be removed and burnt and the infected plants twice sprayed with lime-sulphur solution at intervals of a week or ten days. Three rows of bushes surrounding those actually diseased should be included in the treatment.

JOHNSON (J.) & FRACKER (S. B.). **Tobacco wildfire in Wisconsin.**—*Wisconsin Univ. Agric. Coll. Bull.* 348, 21 pp., 11 figs., 1922.

The wildfire disease of tobacco (*Bacterium tabacum*) has now spread to Wisconsin, making a total of fourteen States affected in the six years since it was first recorded in America. During that period it has caused losses amounting to millions of dollars. In Wisconsin the damage in 1922 was slight, as weather conditions were on the whole unfavourable to its spread.

As regards the source of infection, the writers confirm the views of previous workers [see this *Review*, ii, p. 37] that the disease is traceable almost exclusively to infected seed-beds. One form of attack, apparently peculiar to Wisconsin, is that of 'bud infection', resulting in a pale yellow discoloration of the bud and the surrounding leaves, with entire cessation of growth. This appears to be due to the passage of toxic products from the infected areas through the plant to the bud, causing a bleaching similar to that ordinarily localized in the diseased spots in older leaves.

The bottom leaves of the plants are the most likely to show infection because they are exposed for the longest time in a position favourable to attack. They also appear to be more susceptible to the disease. In the Wisconsin epidemic of 1922 the worst periods of infection followed two separate storms of wind and some hail early in the growing season. Beating rain especially promotes a high degree of infection.

During the six months of the winter season, when there are no tobacco plants in the fields, the number of wildfire germs is greatly reduced by the absence of suitable material for their sustenance, but a few evidently survive on tobacco refuse, seed-bed covers or frames, cured leaves, and the like. Under certain conditions it seems likely that the bacteria may overwinter on the seed, but from the data collected on the source of seed of infected beds in Wisconsin this is evidently not always the case.

In general the greatest injury in the field crop seems to be caused by an upward spread of infection from the lower leaves of the plants, so that the greater the number of primarily infected plants set out, the greater the damage from the disease. When however, conditions for dissemination are favourable, as during driving rain storms, general spread in the direction of the wind occurs, and relatively few infected plants in the field may cause an epidemic later.

The control measures recommended are concerned chiefly with keeping the seed-beds free from disease, and are on the same lines as those recommended in the earlier paper referred to above. Under Wisconsin conditions the safest plan, in case of widespread infection before 1st July, is to destroy the crop and replant the ground from

healthy beds. If only a few plants are affected they may be pulled up, buried or burnt, and replaced by healthy ones. During the first month the tobacco is in the field, an effort should be made to remove all infected leaves, however laborious the process. Ploughing under the suckers after harvesting the crop before they make appreciable growth will effectively prevent their attack by wildfire.

PALM (B. T.) & JOCHEMS (S. C.). **Wilde planten en slijmziekte,** [Wild plants and slime disease.] *Vlugsch. Deli-Proefstat. te Medan* [Sumatra], 20, 3 pp., 1922.

A list is given of thirty-four wild plants, belonging to nineteen different families, which are known to be susceptible to slime disease (*Bacterium solanacearum*) in the tobacco fields of Deli, Sumatra. More than half the names on the list are those of very widely distributed wild plants, the most susceptible of all being *Lantana aculeata*. The cultivation of the latter as a cover crop should therefore be replaced by that of *Mimosa invisa*, which is highly resistant to slime disease [see this *Review*, ii, p. 295].

FROMME (F. D.). **Experiments in spraying and dusting tomatoes.**—*Virginia Agric. Exper. Stat. Bull.* 230, 15 pp., 5 figs., 1922.

Spraying experiments were undertaken in 1918 and 1919 and a dusting experiment in 1922 for the control of tomato diseases in Virginia. The results of the 1918 and 1919 spraying experiments indicate that five applications of Bordeaux mixture with soap (4 lb. $CuSO_4$, 2 lb. resin fish-oil soap, 3 lb. quicklime, and 50 galls. water) provides satisfactory control of leaf blight (*Septoria lycopersici*) and soft rot (probably due to *Bacillus aroideae*). On the basis of these experiments it may be assumed that spraying with soap Bordeaux will result in an average crop increase of 70 per cent. in the middle and western sections of Virginia. Such an increase would approximately cover the cost of spraying and harvesting, when the average price of tomatoes is 30 cents a bushel, while any increase in price above this figure would yield a profit. Standard Bordeaux produced less satisfactory results (36 per cent. of control compared with 68 per cent. with soap Bordeaux).

Seven applications of the Dosch copper lime dust, containing 20 per cent. monohydrated copper sulphate, at the rate of about 42 lb. per acre per application, satisfactorily controlled tomato late blight (*Phytophthora infestans*). Dusting is likely to be preferred to spraying in the higher altitudes to which late blight is chiefly confined, as it is much easier to carry out. The available data indicate that it is probably not equal to soap Bordeaux in the control of the *Septoria* leaf blight, and its value in regions where late blight does not occur remains to be determined.

BEWLEY (W.). **Tomato diseases.**—*Journ. R. Hort. Soc.*, xlvii, 2 & 3, pp. 169–174, 4 pl., 1922.

This paper gives short popular descriptions of the chief tomato diseases in England, some of which are of great commercial importance. Those mentioned include damping off (various fungi, especially *Phytophthora cryptogea* and *P. parasitica*), buck-eye rot or

black rot (*Phytophthora parasitica*), stripe disease (*Bacillus lathyri*), sleepy disease (usually either *Verticillium albo-atrum* or, under exceptionally high temperature conditions, *Fusarium lycopersici*, but other fungi may be concerned), 'mildew' (*Cladosporium fulvum*), stem and fruit rots (*Botrytis cinerea*, *Fusarium*, and *Penicillium* spp., *Bacillus carotovorus*, &c.), root rots (*Fusarium* spp. and a new species of *Sclerotium*), a physiological blossom-end rot of tomato fruit, and mosaic. Methods of control are also briefly indicated.

SCOTT (I. T.) **Tomato wilt.**—*Missouri Agric. Exper. Stat. Bull.* 197, p. 49, 1922.

In this Bulletin, which is the report of the Director for the year ending 30th June 1922, is included a note by I. T. Scott, in which it is stated that the growth of the causal organism of tomato wilt (*Fusarium lycopersici*) was found to be markedly influenced by the hydrogen-ion concentration. A maximum in the growth curve was observed at a PH of about 4·0 to 4·5 in all cases, and a minimum at about 5·5. This was succeeded by another less prominent maximum. The results agree in the main with those already reported for *Gibberella saubinetii* [see this *Review*, i, p. 340].

PAINE (S. G.). & LACEY (MARGARET S.). **Studies in bacteriosis, VII. Comparison of the 'stripe disease' with the 'Grand Rapids disease' of Tomato.**—*Ann. of Appl. Biol.*, ix, 3 & 4, pp. 210–212, 1922.

A comparison between *Aplanobacter michiganense* E. F. Smith, the cause of the 'Grand Rapids' disease of tomatoes, and an *Aplanobacter* which is frequently found associated with *Bacillus lathyri* in stripe disease (see *Ann. Appl. Biol.*, vi, p. 183, 1919) showed certain definite differences. The name *Aplanobacter dissimulans* is therefore proposed for the latter species.

Inoculations of three sets of eighteen young tomato plants with the two species *Aplanobacter* and *B. lathyri* gave negative results with *A. dissimulans* in every case. Many successful infections were obtained with *B. lathyri* and *A. michiganense*, the effect upon the pith being identical. Marked differences, however, were observed in the lesions produced by the two organisms on the exterior of the stem. *B. lathyri* caused the formation of dark brown, sunken furrows, normally without any cracking of the epidermis, while *A. michiganense* produced deep fissures with margins resembling callus formations in the outer cortex, but caused no special changes in colouring or effects on the fruit. The two diseases therefore appear to be entirely distinct, and the earlier suggestion that the Grand Rapids disease might be found to be really due to *B. lathyri* is withdrawn.

GARD (M.). **Sur le dépérissement des jeunes Noyers en 1922.** [On the dying off of young Walnut trees in 1922.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 263–266, 1922.

This paper has already been noticed from another source [see this *Review*, ii, p. 187].

MILES (A. C.). **Keithia on Thuya plicata.**—*Gard. Chron.*, lxxii, p. 353, 1922.

In 1918 and 1919 *Keithia thujina* on *Thuja plicata* occurred more or less generally throughout Ireland, being specially severe in seed-beds in Queen's County and Wexford, and on somewhat older plants in other parts of the country. In the autumn of 1920 the disease appeared simultaneously in widely separated parts of the country. A large proportion of the diseased seedlings have since recovered and there was no serious spread of infection on older trees after 1920. Diseased seedlings saved from the 1918–19 epidemic were planted out, after being sprayed with copper sulphate, on low-lying moist ground in Wexford in the spring of 1920. During 1921 and 1922 these trees have gradually regained a healthy appearance, though they are not yet free from traces of the disease.

The origin of the *Keithia* epidemic is somewhat obscure, since it does not appear to be connected with any particular type of soil or climate, and the possibility of transmission by artificial agency is very remote. In view of the considerable economic importance of *Thuja* the disease should be held in check by the regular spraying of seed-beds and young transplants, and by sowing the seed sparsely to prevent overcrowding, which favours the attacks of the fungus.

HEDGCOCK (G. G.) & HUNT (N. R.). **Notes on some species of Coleosporium, II.**—*Mycologia*, xiv, 6, pp. 297–310, 2 pl., 1922.

Coleosporium ipomoeae (Schw.) Burrill is known to occur in its aecidial stage in the area from Pennsylvania to Florida and Texas on six species of pine, of which *Pinus echinata* is the most common and susceptible host. It is now reported for the first time on *Pinus caribaea* from Florida. The uredo- and teleuto-spore stages of this fungus are found on species of *Calonyction*, *Convolvulus*, *Ipomoea*, *Pharbitis*, and *Thyella* over a much wider range, from New Jersey and Kansas in the north, to Florida and Texas in the south. Successful inoculations were made by the authors on species of *Ipomoea*, *Pharbitis*, and *Quamoclit*.

Coleosporium ribicola (Cke. & Ell.) Arthur has been collected in the pycnidial and aecidial stages on *Pinus edulis* in Colorado and New Mexico. Its uredo- and teleuto-spore stages have been recorded on species of *Grossularia* and *Ribes*, from Wisconsin and Montana to Arizona and New Mexico. The fungus has been successfully inoculated on *Pinus edulis*, *P. pinea*, and a number of species of *Grossularia* and *Ribes*. Between 1917 and 1919 the rust suddenly appeared in Minnesota and Wisconsin, although no aecidial host has been found in these two states; no reason is known for this sudden appearance and the apparent disappearance since 1919. *C. ribicola* in its aecidial stage closely resembles *C. ipomoeae*, and since both may occur on the same host in the north central United States, the authors give a short comparative key to the two species. *Coleosporium solidaginis* (Schw.) Thüm. has been reported as occurring naturally in its aecidial stage (*Peridermium acicolum* Underw. & Earle) on 14 species of pine, chiefly in the eastern United States. In the western States it has been recorded only on *Pinus contorta* in Montana and Colorado. The uredo- and teleuto-spores of

this fungus, in its form on *Solidago*, have been found occurring naturally on about 60 species of *Solidago* in all regions of the United States except in some of the south-western States. It is now reported for the first time on 29 further species, a list of which is given. The form on *Aster* is known to occur on at least 60 species and has a range similar to that on *Solidago*. The results of numerous inoculations made by the writers indicate that in the eastern United States *Coleosporium solidaginis* is a rust attacking species of *Solidago* but not those of *Aster*. The form on *Aster* is apparently distinct and probably belongs to *Peridermium montanum* Arthur & Kern which, if this is the case, is distinct from *Peridermium acicolum*.

HINTIKKA (T. J.). **Die 'Wisa'-krankheit der Birken in Finnland.** [The 'Wisa' disease of Birches in Finland.]—*Zeitschr. für Pflanzenkrankh.*, xxxii, 5–6, pp. 193–210, 1922.

Birches (*Betula alba*) in certain districts of Finland, especially among boulders on the banks of lakes, are subject to a brown streaking of the wood, which is known commercially as 'lily wood' or 'Finnish (Swedish) grained birch wood' and is in considerable demand for the manufacture of furniture. This peculiarity is locally known as the 'wisa' disease, and is stated by different authorities to occur also in Central Europe and Russia and to be due to parasitic attacks or to the overcrowding of the bud-knots.

The symptoms of 'wisa' disease are very variable. Frequently the affected trees present quite a normal appearance except for a few swellings above and below the junction of the branches with the trunk, or ruptures in the bark. The trunk may be deformed, and is generally sloping instead of upright. The brown streaks may occur either in the centre of the trunk or only in the outer annual rings. The so-called 'coarse wisa wood' is usually found only in the trunk, while the 'fine-grained wisa wood' occurs in all parts of the tree. The latter is very popular in the trade.

A detailed description is given of the microscopic characters of the affected wood. The first stages of the formation of the streaks are found on 4 to 5 year old wood and consist in an enlargement of the medullary rays, with a profuse development of stone cells in the adjacent cortex. The cambium and wood curve inward at the affected parts. There are no pathological alterations in the cells at this stage and the author has failed to find any evidence of parasitic attack. Nutritional or climatic influences are believed to be chiefly responsible for the abnormal development.

Later on the cortex and the wood rupture internally along the streaks and the cell contents and walls of the affected tissues turn brown. Tannin and gum appear in abundance in the cells, while the walls of the parenchyma lose their cellulose character. In this condition the tissues may remain for years without further alteration. The fissures are overgrown by newly-formed wood, but the surface of the wood long remains marked by depressions corresponding to the internal cracks. The process of isolation of the latter is accompanied by the formation of callus and wound wood in a tangential direction on one side only of the wound, leading to the formation of kinks in the wood which may resemble knots.

Other types of internal tissue distortions produced in various ways during the healing process are described.

The author believes that the 'wisa' disease is a non-parasitic form of gummosis, of the type described by Sorauer as latent, and thought by him to precede the stage of visible gum flow. In the 'wisa' disease the latter stage, characterized by gummy degeneration of the cell walls and of the cell contents, is never fully reached. While it is admitted that the symptoms suggest one of the so-called enzymic group of diseases, this view is not supported by the peculiar distribution of the disease, the obvious influence of external factors and especially of climatic conditions on it, the anatomical characters of affected tissues, and the varying susceptibility of individual trees or branches. The whole question of the etiology of the disease is considered to be still obscure.

GLASSON (A. K.). **Mortality of Sal in Buxa Division, Bengal.**—*Indian Forester*, xlviii, 1, pp. 22–31, 1922.

An account is given of an inquiry instituted to ascertain the causes of the high rate of mortality of sal [*Shorea robusta*] in the Buxa Division of Bengal. One branch of the work consisted in the investigation of the sal root fungus (*Polyporus shoreae*), ten plots being demarcated in various parts of the Division for purposes of observation. Two of these have now been under observation for 6 years and the others (each of 4 acres) for $4\frac{1}{2}$ to $5\frac{1}{2}$ years.

It was found to be very difficult to arrive at any accurate conclusion as to the rate of spread of the disease, the fungus frequently being well established in a tree before any external signs of attack become apparent. As regards the lapse of time between the first perceptible sign of attack and the death of a tree, the results of the observations were also conflicting. Some trees which had sporophores on them six years ago are still alive and healthy, while others died almost immediately after showing symptoms of infection. Up to May 1921 the average mortality associated with the sal root fungus was 1·25 per cent. per annum, the average total mortality being estimated at 1·6 per cent. These figures are probably above the general average over the whole forest. An increased number of infected trees became noticeable at the end of the observation period. As mentioned above, however, it is possible for the disease to exist in a tree for years before producing any external symptoms, so that it would be unsafe to make any deductions from the present data as to the rate at which the infection spreads.

A further analysis of the deaths showed that the mortality associated with the fungus was about equal for all girth classes. Deaths due to the fungus appear to occur in groups, thus causing the formation of gaps in the stand. This point is of some importance in growing pure plantations of sal.

The observation plots are being maintained and in time should give further information regarding the incidence of mortality and rate of spread of the disease.

DE WILDEMAN (E.). **Les maladies de l'Arachide.** [The diseases of Groundnut.]—*Rev. de Bot. appliquée*, ii, 15, pp. 631–633, 1922.

The author supports a recent recommendation by Chevalier in

the same *Revue* that uncontrolled importation of American groundnuts [*Arachis hypogaea*] into Africa should be prohibited, in view of the danger of introducing *Puccinia arachidis*. He considers that all imports of groundnuts should be controlled, since other, not less important diseases occur elsewhere. Of these, two are particularly mentioned, due respectively to *Septogloeum arachidis* [*Cercospora personata*] and *Bacillus solanacearum*, and are stated to cause great damage in the Dutch East Indies. The latter is not mentioned on this crop in Africa but the former is already known there.

GLEISBERG (W.). **Das Rätsel der Hernieverbreitung.** [The mystery of the dissemination of club-root]. *Nachrichtenbl. deutsch. Pflanzenschutzdienst*, ii, 11, pp. 89–90, 1922.

Club-root of cabbage [*Plasmodiophora brassicae*] is widespread throughout Silesia, occurring with particular frequence and virulence in small holdings and allotments. In the Zoological Experiment Station at Proskau a series of laboratory experiments was instituted to ascertain the influence of the earthworm on the spread of the disease. Three to ten earthworms of various sizes, after being kept for a month in flower pots in infected soil, were placed in fresh pots, the soil of which was free from infection. Cabbage seed was sown in the latter series of pots, and also in a corresponding number without earthworms in infected and non-infected soil. At the end of two months the infected soil without earthworms had 100 per cent. of the plants attacked, the healthy soil without earthworms had 0 per cent. and the healthy soil with earthworms had 60 per cent. The dissemination of club-root in the soil through the agency of earthworms is thus possible. For practical purposes it is immaterial whether the infection is carried in the mucilage of the skin or in the intestinal contents, but the results of further experiments indicated that *Plasmodiophora brassicae* is present in an extremely virulent form in the excreta of worms.

The results of these tests emphasize the danger of leaving decaying cabbage stalks in the field, as worms frequently penetrate the tissues in large numbers in the spring. The prevalence of the disease in small gardens and other confined areas is explained by the shorter distances which the worms must traverse between the cabbage plots. In the control of the disease the disinfection of the soil is only likely to be of value if simultaneously carried out on all plots within the range of the worms. Deep ploughing is a purely temporary palliative, since the worms rapidly bring infective material again to the surface.

THATCHER (R. W.). **Forty-first Annual Report New York Agricultural Experiment Station (Geneva) for 1922**, 51 pp., 1923.

Some items of phytopathological interest are contained in the report of the Division of Botany [pp. 29–34].

Raspberry disease investigations were instituted in 1922 in the Hudson River Valley, where the future of the crop is threatened by several diseases. A survey of the plantations showed that the mosaic or yellows disease is universally present. For the last ten

years in this area the red variety Perfection has been cultivated almost exclusively, and mosaic apparently became prevalent in the early plantings from which all the present stands have descended. A small quantity of healthy stock was obtained for experimental purposes, and tests will be carried out to determine the most practical methods of selecting and growing disease-free plants. Mosaic is the most important disease of red and purple raspberries in New York, black raspberries, blackberries, and dewberries being also affected by a similar and probably identical disease. Studies have been made of the varying symptoms of mosaic, especially the first stages, in the Division of Horticulture, and investigations are in progress on the rate of spread of the disease from infected to healthy plants, and the natural factors involved in its transmission.

Western blue-stem disease has ruined the black raspberry industry in Dutchess county of recent years. The disease is not completely understood, and no control measures are known.

Rosette or eastern blue-stem [see this *Review*, ii, p. 128], which in some respects resembles mosaic, primarily attacks black and purple raspberries. A preliminary study of its importance in New York is in progress.

Carrots on Long Island are liable to a destructive leaf blight caused by *Macrosporium carotae*, while a root rot of unknown origin is also of some importance. The leaf blight disease is seed borne, and seed disinfection experiments will therefore be carried out. Trials will also be made with Bordeaux mixture, which appears to be a promising method of treatment.

DOIDGE (ETHEL M.). [**Report of the Division of**] **Botany and Plant Pathology** [**for the year ending 30th June 1922.**]—*Journ. Dept. of Agric. S. Africa*, v, 6, pp. 546–549, 1922.

Citrus canker [*Pseudomonas citri*] eradication continues to make satisfactory progress, only four trees being found infected during the year, all on one farm in the Rustenburg district. An extensive field experiment is being carried out to ascertain whether citrus trees may safely be replanted after three to five years in orchards where trees infected with canker have been removed. Citrus scaly bark has only been known in South Africa for the last two years, but appears to be spreading very rapidly in certain areas.

The outbreak of potato wart disease (*Synchytrium endobioticum*) in Natal [see this *Review*, ii, p. 10] seems to be confined to two adjoining farms in the Impendhle Division, and it is hoped that the disease has not become more widely distributed. No cases of infection have occurred in the Boston area, near Impendhle, where potatoes are grown in considerable quantities. Two obscure diseases of groundnut were observed; in one case the plants turn yellow and die without apparent cause, and in another seemingly healthy plants produced a large crop of kernel-less nuts. Amongst the plant diseases mentioned as being under observation in the western Cape districts are silver leaf disease of fruit trees [*Stereum purpureum*] and apple mildew. Other aspects of the mycological work referred to in the Report have been, for the most part, separately noticed in this *Review*.

In the National Herbarium at Pretoria, an up-to-date reference index was compiled of the 1,000 odd genera of fungi represented, with special reference to their systematic position.

Departmental Activities: Botany.—*Journ. Dept. of Agric. S. Africa*, vi, 2, pp. 114–115, 1923.

Climatic conditions in the Transvaal are stated to have been particularly favourable for the development of anthracnose (*Gloeosporium ampelophagum*) in grape vines in the past season, and considerable damage to both shoots and fruit has resulted. Winter treatment is recommended, which consists of pruning out and burning all affected wood and then spraying the dormant vines with a solution of lime-sulphur (1 : 12), or swabbing them with a mixture of iron sulphate (25 lb.), sulphuric acid (1 pint), and water (50 galls.). If after this treatment young shoots are found to be affected, spraying with Bordeaux mixture should be carried out (*a*) when shoots are eight to twelve inches in length, (*b*) just before the flower-buds open, (*c*) just after the blossoms fall, and, if necessary, once or twice again later.

Chlorosis in fruit trees is becoming more and more widespread in South Africa, and while in some cases purely cultural remedies have been effective, in others no treatment tried has had successful results. The trouble has been reported from several districts in Cape Colony, while in the Transvaal many apricots, plums, pears, and apples have been affected, the latter trees in a characteristic, variegated manner.

Report of the Minister of Agriculture, South Australia, for the year ended 30th June, 1921, 79 pp., 1922.

The Report contains various scattered references of phytopathological interest included in the annual survey of the work of experimental farms and orchards. At Berri, River Murray, *Oidium* and anthracnose [*Gloeosporium ampelophagum*] of the vine occurred, the former being controlled by dusting the vines with flowers of sulphur. A late infection by downy mildew [*Plasmopara viticola*] was also reported, but no appreciable loss was caused. In the Mount Lofty Ranges black knot of cherry, probably caused by a fungus, occurred on old trees in several orchards. Root gall was prevalent on the sandy soils of the Mypolonga Irrigation Area, where it caused severe losses. Root rot (*Armillaria mellea*) of apple trees was reported from several localities. Anthracnose of the vine was prevalent, and anthracnose of the gooseberry [*Pseudopeziza ribis*] appeared in several gardens, chiefly on the Ostrich variety.

Darnell-Smith (G. P.). **Biological Branch.**—*Ann. Rept. Dept. of Agric. New South Wales 1920–21*, p. 27, 1922.

The number of specimens examined on behalf of the general public in connexion with fungous diseases of plants was the highest on record. In conjunction with the Fruit Branch and orchard inspectors, field experiments have been carried out for the control of sour sap of apple, collar rot of citrus, citrus exanthema, brown rot of stone fruits [*Sclerotinia fructigena*], black spot of Williams pears and apples [*Venturia pirina* and *V. inaequalis*], downy

mildew of the vine [*Plasmopara viticola*], the black spot disease of orange due to *Phoma* [*citricarpa*], and *Armillaria mellea* on citrus.

Considerable attention was given to the bunchy top disease of bananas [see this *Review*, i, p. 108, and ii, pp. 131, 372], resulting in the isolation of a number of organisms from infected corms. Owing to the unsatisfactory conditions under which the inoculation experiments were conducted no definite conclusions as to the nature of the disease could be drawn.

The following diseases were also under investigation: take-all of wheat [*Ophiobolus cariceti*], gummosis of sugar-cane [*Bacillus vascularum*], blue mould of tobacco [*Peronospora hyoscyami*], and the treatment of seed potatoes for scab [*Actinomyces scabies*]. The officers of the branch also submitted reports, some of which have been prepared for publication in a scientific series, on the following diseases: *Helminthosporium* of wheat [see this *Review*, i, p. 340], various diseases of sorghum, aster wilt, spotted wilt of tomato, tomato seedling diseases, Fiji disease and bunchy top of sugar-cane, woodiness of the passion vine, brown rot of pomegranates, *Alternaria* spot of orange, *Sclerotium rolfsii* and its hosts, cross-inoculation with *Gloeosporium* sp. from the stem of rose to apples, blotch condition of apples, a disease of *Pinus insignis* [see this *Review*, ii, p. 299], and palm and pepper seedling diseases.

During the year, imported plants, consisting chiefly of fruit stocks and seeds, were examined with a view to preventing the entrance of any serious disease into the State. *Cylindrosporium padi* was found for the first time on some cherry stocks imported prior to the fireblight proclamation by the Federal Government. Powdery scab (*Spongospora subterranea*) was detected in Tasmanian potatoes.

Downy mildew of the grape, spotted wilt of tomato, brown rot of stone fruits, and brown spot of the mandarin [*Colletotrichum gloeosporioides*] were all serious. The last-named appears to be extending into new areas. A *Dematium*-like fungus resembling *Aureobasidium* was isolated from grapes and vine leaves in Cumberland county.

Report on the Department of Science and Agriculture, British Guiana, for the year 1920, 92 pp., 1922.

The Economic Biologist, Mr. G. E. Bodkin, reports that a great reduction has taken place in the area in the Colony devoted to Para rubber cultivation owing to the South American leaf disease (*Melanopsammopsis ulei*). The Departmental Station at Christianburg had to be abandoned as 95 per cent. of the trees were affected by the disease, which subsequently became very prevalent at Issorora, the yield of dry rubber from tapped trees having sunk from 4·97 lb. in 1919 to 2·4 lb. in 1920. Trees which have been at all seriously attacked by the disease never recover their original vigour. The fungus is indigenous on the native rubbers, *Hevea confusa* and *H. guyanensis*, neither of which, however, suffers to the same extent as *H. brasiliensis*. The virulence of the disease depends greatly on meteorological conditions, its ravages being particularly severe during protracted periods of heavy rainfall. At such times the young leaflets shrivel up a few days or even hours

after the buds burst. This virulent form of the disease is largely in abeyance during relatively dry periods, the leaves remaining green though riddled with small holes. Even slightly affected trees show a falling off in yield and fail to make a satisfactory increase in girth. In every plantation a few trees appear to be immune from the disease, but the reason of their resistance is not known.

Bud rot of coco-nuts was prevalent, especially among trees growing on 'pegassy' soil in the north-western district. The most severe attacks occurred on trees which had reached the bearing stage (ten to twelve years old). Defective drainage and cultivation were found to encourage the spread of the disease. Red ring disease of coco-nut palms [caused by the nematode *Aphelenchus cocophilus*] was also recorded.

'Ripe rot' of mangoes and breadfruit was observed, but was readily controlled by the application of Bordeaux mixture.

Witches' broom disease [*Marasmius perniciosus*] of cacao was in evidence on some estates where the proper cultural measures were neglected.

WELSFORD (E. J.).—**Yearly Report—April to December 1921.**—*Rept. Agric. Dept., Zanzibar Protectorate, for 1921*, p. 136, 1922.

Owing to the lack of apparatus for detailed work the greater part of the year was spent in the examination of clove [*Eugenia caryophyllata*] 'shambas' [gardens]. Inspection of the roots and of soil around dead and dying trees indicated conclusively that the sudden death of certain trees was not due to the physical constitution of the soil or to senility. Two parasites were found on the clove, which are believed to be respectively responsible for two distinct diseases, die-back and 'sudden death'. Experiments have been undertaken to test the effect of a dressing of lime on the acid soil of the shambas. So far the results have been beneficial.

Much of the 'mhogo' [= cassava, *Manihot utilissima*] crop in Pemba is severely infected by a fungous disease which greatly reduces the yield.

An experimental garden has been started at Weti for plant disease work and improving existing varieties of the more useful crops. The sweet potato, yam, mhogo, and pigeon pea are under cultivation.

BROWN (NELLIE A.). **Experiments with Paris Daisy and Rose to produce resistance to crown gall.**—*Phytopath.*, xiii, 2, pp. 87–99, 2 pl., 4 figs., 1923.

In trying to obtain a strain of the Paris daisy [*Chrysanthemum frutescens*] resistant to crown gall, the author took perfectly healthy plants, inoculated them with *Bacterium tumefaciens* and when the galls had developed, took cuttings again, the process being repeated several times in the hope that resistance would eventually develop.

Two series of experiments were made. In the first an apparent resistance developed up to the fifth set of cuttings, but with a strain of the bacterium isolated from slowly developed galls on this set, the resistance gave way and the plants two generations later were killed. In the second series this virulent strain of *B. tumefaciens*

was used, and the plants died out in the sixth set of cuttings. The results of both series are interpreted as indicating that the vitality of the plants was considerably reduced by repeated infection with the organism.

When the fifth set of cuttings in the first series were showing apparent resistance to grown gall, juice from the diseased plants was expressed and added to beef agar, and juice from healthy plants treated likewise. Colonies of *B. tumefaciens* were slower in appearing on the former medium than on the latter.

Plants inoculated with dead cultures and then in the same spot with living ones also showed a marked decrease of successful infections.

Breeding experiments with rose seedlings on similar lines as with the Paris daisy, except that the plants were propagated by seed instead of cuttings, produced a seedling which appeared quite resistant, but in two years this resistance had appreciably lessened.

WEBER (G. F.). **Septoria diseases of cereals. III. Septoria disease of Rye, Barley, and certain grasses.**—*Phytopath.*, xiii, 1, pp. 1–23, 9 figs., 1923.

This paper, the last of a series of three, deals with five distinct diseases.

The *Septoria* leaf blotch of rye caused by *S. secalis* Prill. & Del. is described first. The disease produces small, almost circular spots confined to the leaves or larger areas involving sometimes the whole leaf area. The causal organism, described in 1889 from France, grows readily in culture, producing white colonies which do not bear conidia but only pycnidia containing 3-septate pycnospores, 2 to 3·5 by 25 to 49 μ. Inoculations with the latter on eight kinds of cereals showed that only rye was susceptible. The disease has appeared more or less sparingly in the United States, but is not of economic importance.

Septoria leaf blotch of barley, caused by *S. passerini* Sacc., is characterized by lesions of a very indefinite outline, the yellow diseased area gradually blending to the normal, and has pycnidia which appear as black specks, not confined to the yellow areas, containing 3-septate pycnospores measuring 1·7 to 3 by 23 to 46 μ. The organism grows well on potato dextrose agar, forming flesh-coloured colonies of conidia (which are exactly like the pycnospores) becoming black with age. The disease, previously reported from Italy, is confined to barley, and it is not important economically.

Septoria leaf blotch of quack grass (*Agropyron repens*), caused by *S. agropyri* Ell. & Ev. has only been reported from the United States, and so far as is known *A. repens* is the only host attacked. The fungus was readily obtained in pure culture and on potato-dextrose agar developed circular, raised, smooth, conidial colonies, first pinkish-rose in colour and later turning black. The pycnospores and conidia are 3-septate and the former measure 1·5 to 2·5 by 24 to 45 μ.

The *Septoria* leaf blotch of brome grass (*Bromus inermis*), caused by *S. bromi* Sacc. and previously reported from Italy, is now recorded for the first time from the United States. It does not attack the common cereals and is of negligible economic importance.

The spots resemble those caused by other species of *Septoria* on the Gramineae, and the pycnidia bear spores 1·5 to 2·5 by 31 to 50 μ. The fungus grows well in artificial culture producing a white mycelium, which later turns olivaceous. Conidia are not mentioned.

A leaf blotch of Kentucky blue grass (*Poa pratensis*) is reported as being caused by a species of *Septoria* which resembles *S. graminum*, but differs from the latter in the lesions not being delimited by veins, in the pycnidia being much less closely seriately arranged, and in the measurements of the pycnidia, 50 to 120 μ in diameter, and of the pycnospores, 1 to 1·5 by 29 to 57 μ. The fungus grew readily in culture, the colonies consisting first of conidial masses with scant mycelium, but later producing olivaceous hyphae, and resembling greatly those of *S. tritici*, *S. passerini*, and *S. agropyri*. Inoculations on 40 graminaceous plants gave successful results only on *Poa pratensis*.

Reddy (C. S.) & Godkin (J.). **A bacterial disease of Brome-grass.** —*Phytopath.*, xiii, 2, pp. 75–86, 2 pl., 1923.

The authors describe in this paper a new disease of brome grass (*Bromus inermis*) caused by a bacterial organism.

The disease first appears on the leaves as light olive green, circular to elliptical, water-soaked areas, with light brown centres. Later the spots become dark brown, almost black, and a characteristic halo, visible in the early stages, becomes more prominent. In severely attacked plants, the panicles wither and die, producing symptoms similar to frost injury.

Each year from 1917 to 1921 the disease occurred on *Bromus inermis* in North Dakota, and it has also been noted in Wisconsin on the same host.

Isolations were made readily and successful infections obtained without difficulty, the ends of the first leaves turning black and withering in two to four days, and the more typical lesions developing in three to nine days. Twenty-three species of *Bromus* were found to be susceptible, although in five cases the centres of infection did not become black, but were small, sunken, and light grey, thus resembling to a marked degree the halo blight of oats caused by *Bacterium coronafaciens*. Inoculations with the latter organism, however, gave negative results with all species of *Bromus* tried except *B. carinatus*. Four cereals and six other grasses yielded negative results with the brome grass organism, whilst *Agropyron repens* and oats were slightly susceptible.

The organism resembles *B. coronafaciens*, but on account of the differences in infectivity between the two organisms, the authors regard it as a new variety, and have named it *B. coronafaciens* var. *atropurpurem*. A long series of physiological tests was applied to both organisms, but no striking differences could be discovered. The brome grass organism has the group number 211.2323023 and the same number is suggested as correct for *B. coronafaciens*.

Newton (Margaret). **Studies in Wheat stem rust (Puccinia graminis tritici).**—*Trans. R. Soc. Canada*, 3rd series, Section V, xvi, pp. 153–210, 6 pl., 3 figs., 1922.

After a brief reference to the economic importance of wheat stem

rust (*Puccinia graminis tritici*) in Canada, and to the history of the discovery of biologic forms of the parasite, the author gives details of her investigations, started in 1918, to determine what strains occur in Western Canada. In her experiments she adopted Stakman and Levine's differential key to the biologic forms, as well as their symbols for recording the type and degree of infection [see this *Review*, ii, p. 158]. Tables and diagrams are also given, illustrating the results of collections and of inoculation experiments on eleven varieties of wheat belonging to the same groups as used by Stakman and Levine, together with a report on preliminary infection experiments with twenty-nine species of grasses.

The investigation demonstrated the presence in Canada of fourteen biologic forms of *Puccinia graminis tritici* identical with fourteen of the forms isolated by Stakman and Levine in collections from widely separated points in both the northern and southern United States. This fact, the more interesting as it was previously thought that the rust in the protected foot-hills of the Rocky Mountains and in north-western Alberta, might be different from that found in the open plains of the Red River Valley of Canada and the United States, suggests that climate is not a controlling factor in the distribution of these forms.

In consideration of the generally accepted hypothesis that rust moves during the season in waves from south to north across the continent, collections were made in the field from the time the first pustules appeared in early summer until late in September. It was thought that if this hypothesis were correct, and if the biologic forms varied in point of origin, they would appear at successive dates during the summer, varying with the remoteness of the point of origin. Although in the three years under review no definite succession of biologic forms was found, it was noted that the same form, XVII, appeared first each year, having been collected as early as 5th July, while the form IX, which attacks emmer heavily, was always one of the last, seldom appearing before September, thus suggesting that the former may be more local in origin, and the latter carried by winds from farther south. Usually more than one form was found on the same wheat variety, sometimes even on the same plant: thus, forms III, IX, and XVII were found on a single plant in Saskatchewan.

A striking fact emerging from these investigations is the constancy of behaviour of the biologic forms. Association of the same form with a great variety of hosts, in widely separated localities, was without apparent effect on its biologic characters. Inoculations on the test wheats invariably gave the same results, whether the inoculum was obtained from the same varieties, or from very different hosts even when the fungus had been cultured on the latter for several generations, thus supporting the conclusions of Stakman, Piemeisel, and Levine. The frequently expressed idea that a permanently rust-resistant variety cannot be bred owing to the plasticity of the rust is erroneous, and rests on the misleading interpretation, either of the results obtained by a person unfamiliar with the exacting technique required in the study of biologic forms, or of the morphological variations in the uredospores; the latter may vary in size under the influence of the resistance of the host

and other cultural factors, but such variations within a given form should not be confused with true morphological distinctions.

The geographical distribution of the biologic forms is still imperfectly known. However, tentative maps have been prepared showing the areas in which the six more frequently occurring forms have been collected, but further exploration will, no doubt, extend the limits so far found.

Referring to Stakman's statement that 'Methods of breeding for rust resistance must now be changed fundamentally. The breeder must know and work with those forms of rust which occur in the region for which his new variety is intended', the author states that the six forms I, IX, XVII, XXI, XXIX, and XXX, all of which give the same reactions on the bread wheats, and constitute together 70 per cent. of all the collections, deserve the first attention of Canadian wheat breeders, since there is ground to hope that when a hard spring wheat is evolved which is resistant to any one of these six forms, it will likewise prove resistant to the others; this would effect a very considerable reduction in the annual losses from wheat rust. Genetic material bearing the necessary factors for rust resistance for eleven out of the fourteen Canadian forms hitherto isolated, is available in the common and durum wheats. Kanred, for instance, is immune from all of the six biologic forms predominating in the principal wheat-growing areas of Canada and from two others, though it is susceptible to the remaining six forms.

The second part of the paper deals with the author's researches on the development of the parasite within the tissues of resistant and susceptible hosts. The experiments, technical details of which are given, showed that up to its entry through the stomata, the development of the fungus follows the same course on either a resistant or susceptible host. In the latter the parasite may then continue its growth and complete its cycle with the formation of a new uredosorus, the host apparently adjusting itself readily to the presence of the fungus. In a resistant host, the tissues appear to be intolerant of the parasite. The progress of the hyphae sent out from the sub-stomatal vesicle is rapidly checked. The failure of infection in this case appears to be due to the starvation of the parasite by the local killing of the intolerant host tissue, as the author has found in most cases some indication of disintegration in the host cells before a similar breakdown could be observed in the hyphae. Miss Allen's suggestion [see this *Review*, i, p. 377] that the resistance of Kanred wheat may be due to the narrow stomatal openings of this variety is not supported, since some of the forms to which this wheat is highly susceptible have germ-tubes not appreciably narrower than those of forms from which it is immune, and even in the latter penetration of the stomata is not rare.

A bibliography of 67 titles is appended.

WESTON (W. H.) **Production and dispersal of conidia in the Philippine Sclerosporas of Maize.**—*Journ. Agric. Res.*, xxiii, 4, pp. 239–277, 10 pl., 2 figs., 1923.

This paper deals chiefly with the production and dispersal of the

conidia of two Philippine species of *Sclerospora* parasitic on maize, namely, *S. philippinensis* and *S. spontanea*. The production of conidia on infected plants is preceded by the formation on leaves and sheaths of characteristically discoloured, yellowish-white areas, which are defined in the very young leaves and show no tendency to subsequent spread. Production takes place in the greatest relative quantity on the largest of these areas, some of the smaller stripes and spots remaining barren, and it always occurs during the night, generally in cool, moist weather. The conidiophores develop during the night exclusively from the stomata, when the surface of the plant is covered with dew or rain. From the mycelium in the underlying tissue, branches protrude through the stomatal pores, forming crowded groups of lobed and knob-shaped outgrowths which are not completely developed until some two to four hours after the surface of the plant has been covered with moisture. They later elongate, developing successively into mature conidiophores in about another three hours. Several conidiophores are formed at each stoma during the night. The conidia, which mature in greatest numbers about 2.30 a.m., are apparently set free by active ejection from the sterigmata, rather than by passive disjunction, as previously assumed. The nocturnal development of conidiophores follows a relatively regular cycle under normal meteorological conditions.

Conidia are produced in enormous numbers, even a small plant liberating sufficient to infect the neighbourhood. Estimates of the total number of conidia produced on a single plant of Native Yellow maize during one night ranged from 758,033,400 to nearly 6,000,000,000. This process continues night after night for months, finally resulting in an almost inconceivable figure.

The dispersal of conidia necessarily takes place at night and is accomplished chiefly by wind. Slight air-currents and strong breezes are both important, since they occur very frequently at the time of maximum conidiophore production. Violent gales do not promote the copious production of conidia, but are important in so far as they sweep the available conidia over greater distances. Dispersal is also effected by splashing drops of rain or dew, laden with conidia, either falling from infected leaves directly on to healthy ones or being transported thence by the wind. Agents of minor importance in the transmission of conidia are surface water, insects, and moist infected soil.

The genus *Sclerospora* may be disseminated in three stages of development—mycelium, oospores, and conidia. The first two stages are comparatively unimportant in the Philippines, the destructive spread of the downy mildews being almost entirely accomplished by conidia. The spread of these diseases to the United States could not, however, be effected by conidia unless the latter developed on imported live plants. Oospores have not been found on maize in the Philippines, and it is not yet known whether any of the oospore-forming *Sclerospora* spp. on other Gramineae are identical with the maize parasites. As mycelium, long-distance transport might occur in sugar-cane (which is also attacked by *S. spontanea*) or possibly in cuttings of other grasses.

HURD (ANNIE M.). **Hydrogen-ion concentration and varietal resistance of Wheat to stem rot and other diseases.**—*Journ. Agric. Res.*, xxiii, 5, pp. 373–384, 1923.

The present investigation was undertaken with a view to furnishing additional data on the hydrogen-ion concentration of the expressed juice of a number of wheat varieties, some resistant and others susceptible to stem rust (*Puccinia graminis*). Most of the plants used in the experiments were grown in the greenhouse, but germinator seedlings were also studied. The hydrogen-ion concentrations were determined electrometrically, and most of the measurements were made at a temperature of 25° C. Throughout the series the procedure was to make at least three determinations of each sample, the average of which was taken to represent the reaction of the juice.

The most striking result revealed by the data was the absence of any significant difference in the P_H values of the juice of resistant and susceptible varieties of wheat. The variations in the reaction of the juice of the plant at different stages of development were also very slight, only a small increase in acidity being observed in seedlings two to four weeks old over those of one week.

A table of the reactions of different well-known wheat varieties to other common diseases besides stem rust (bunt, mildew, scab, &c.), compiled from the observations of several investigators, indicates very inconsistent behaviour. The only examples of uniform resistance and susceptibility are Khapli and Little Club respectively.

It may be concluded from the above data that there is no correlation between the hydrogen-ion concentration of the expressed juice and varietal resistance or susceptibility to disease.

Much greater differences in the hydrogen-ion concentration of the expressed juice were produced by environmental than by varietal factors. Thus the P_H value of the juice of greenhouse wheat seedlings cut at 1 p.m. averages 0·1 higher than that of those cut at 9 a.m. Wheat plants grown in limed soil have a lower hydrogen-ion concentration than those from unlimed ground. General debility, as well as severe infection by *Erysiphe graminis*, results in an abnormally high acid content. No appreciable differences in the hydrogen-ion concentration were observed in wheat plants grown from seed originating in widely separated localities. The concentration of hydrogen-ions in expressed wheat juice increases on standing. The addition of two volumes of water to one of expressed juice increased the P_H value by 0·10 to 0·15. Young germinator seedlings are more highly buffered against dilution than older greenhouse plants.

BEAUVERIE (J.). **Sur les rapports existant entre le développement des rouilles du Blé et le climat.** [On the relation existing between the occurrence of Wheat rusts and climate.]—*Comptes Rendus Acad. des Sciences*, clxxvi, 8, pp. 529–531, 1923.

Comparative field observations on the occurrence in 1921 and 1922 of three rusts (*Puccinia graminis*, *P. glumarum*, *P. triticina*) on some fifty varieties of wheat, in Auvergne (France), gave some interesting indications in view of the extremely divergent weather conditions of the two years. In 1921, during the critical

period in May and the beginning of June (which the author in previous work has given reasons for regarding as the period during which, under local conditions, the weather exercises the maximum influence on the wheat crop), the rainfall in the neighbourhood of Clermont-Ferrand [for periods of ten days each] amounted to 22·9 mm., 65·6 mm., and 12·6 mm., and was followed by a period of absolute drought up to the harvest. In 1922 the total rainfall was considerably smaller during the earlier period, but rainy weather followed until the end of the season. In the former year *P. glumarum* was very prevalent at the beginning of active growth and during the wet period mentioned; as dryness set in, *P. triticina* appeared and was present with an average intensity until the harvest, while *P. graminis* was totally absent. In 1922 *P. glumarum* was present to a slighter extent during the first vegetative phase, but maintained itself on the young shoots; *P. triticina* appeared a little later and developed feebly; *P. graminis* was the last to appear but gained in intensity up to harvest time.

From the above observations, which, however, the author remarks were not controlled by experiment, and which should be continued for several years to become of practical significance, he draws the conclusions that the wheat rusts occur in the following sequence: (1) *P. glumarum*, (2) *P. triticina*, (3) *P. graminis*. The first is a rust of the first vegetative phase and of the tillers, the second is the chief rust in dry years, and the third is especially prevalent during wet years. This is said to agree with the observations in other countries. Thus, in the dry regions of the United States the prevalent rust is *P. triticina*, *P. graminis* being seldom found; but the latter can cause heavy damage in periods of high humidity.

Some notes are also given on the relative susceptibility of the varieties cultivated by the author in the two years under review, special mention being made of Kanred CI 5146, which was highly resistant and showed no trace of rust in 1922.

BLARINGHEM (L.). **Sur la résistance aux parasites cryptogamiques d'un hybride d'Epeautre et de Seigle.** [On the resistance to cryptogamic parasites of a hybrid from Spelt and Rye.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 267–276, 2 figs., 1922.

The author describes the behaviour of a hybrid from *Triticum spelta* var. *T.* (female) and *Secale cereale* (male) in regard to rusts and ergot. A noteworthy feature of this hybrid is its great vegetative vigour, which results in the production of a dry weight at least eight times that of the parents in the same growth period. This is accompanied by feeble and delayed lignification of the tissues, the transpiration and assimilation are prolonged after the ears dry up, and the latter are completely sterile.

Of the parents, both the autumn and the spring sown rye were heavily attacked by *Puccinia graminis*. On harvesting in the first days of August, fully developed sori of *P. dispersa* were also found at the base of the leaf sheaths underneath the uncracked epidermis. The spelt wheat suffered considerably less from *P. graminis*, though a late attack developed between the 25th July and 4th August, the date of harvest. The plot sown on 4th March was much more affected than that sown on 20th March.

The hybrid was much more resistant to rust attacks during its growing period than either of the parents. Teleutospores of *P. graminis* showing a number of morphological divergences from the normal appeared only on the shoots which developed after cutting in August. The sori were larger and more confluent than those on the wheat, and the teleutospores were much more variable and frequently apiculate instead of rounded or flattened at the free end. These peculiarities are thought to be the result of the softer tissues of the hybrid and the deeper position of the sori, many of the spores of which do not come in contact with the epidermis at their tips.

The slow unfolding of the spikelets, which in the hybrid have exceptionally elongated axes, seems to have been more favourable to infection by the spores of *Claviceps purpurea* than was the case with the parent rye. The ergot on the hybrid was shaped more like a grain of wheat than of rye, a fact in harmony with the production in other fertile wheat × rye hybrids, of grain resembling wheat rather than rye.

O'Byrne (F. M.). **Bordeaux-oil emulsion. Its preparation and use.**—*Quarterly Bull. State Plant Board of Florida*, vi, 2, pp. 46–58, 1922.

Bordeaux-oil emulsion, the principal use of which is for the control of citrus scab and melanose [*Phomopsis citri*], should be prepared as follows:—(*a*) Dissolve copper sulphate in a barrel at the rate of 1 lb. per gallon of water; (*b*) slake rock lime in water and then add water until the number of gallons is equal to the number of pounds of lime used (if hydrated lime is used double the amount will be required). To mix 50 gallons of Bordeaux of the 3-3-50 formula, 22 gallons of water should be put into the sprayer, and 3 gallons of solution (*b*) added. Then put 22 gallons of water into a barrel and add 3 gallons of solution (*a*). The barrelful of diluted copper sulphate should then be poured slowly into the diluted lime solution in the sprayer, stirring the whole time. The resulting solution is first-class Bordeaux mixture which will stay in suspension for a long time and adhere to the plants. While stirring rapidly, add very slowly indeed 3 quarts of oil emulsion.

The following is the formula for oil emulsion used: 2 galls. paraffin oil, 1 gall. water, 2 lb. caustic potash fish oil soap, 1 lb. ground glue, and 2 to 4 oz. 50 per cent. carbolic acid or liquor cresolis composition.

It must be remembered that infection by the scab organism occurs some time before the disease becomes perceptible on the surface, and the spraying should therefore be started in the early spring. To control scab on the fruit the spray should be applied directly to the blossom. This can be done without risk of injury. The time to spray for melanose is from ten to twenty days after the petals have dropped. Excellent results have been obtained for the past three years in an experimental nursery at Gainesville by the use of 3-3-50 Bordeaux mixture, with or without the addition of oil emulsion, the control of scab being absolute. The operations were carried out at fortnightly intervals from March to November, and were not followed by any injurious results. Both ammoniacal

solution of copper carbonate and lime-sulphur considerably reduced the amount of infection, but neither was equal to Bordeaux in efficiency.

BURGER (O. F.), DE BUSK (E. F.), & BRIGGS (W. R.). **Preliminary report on controlling melanose and preparing Bordeaux-oil.**—*Florida Agric. Exper. Stat. Bull.*, 167, pp. 132–140, 6 figs., 1923.

Melanose and stem-end rot, both caused by *Phomopsis citri*, are the most serious diseases of citrus in Florida. The former is responsible for a larger percentage of low-grade and unsightly fruit than any other disease, and the latter causes more losses through premature dropping and decay than all other agencies combined. Melanose is distributed throughout Florida, but appears to be more prevalent on the west coast and in the central districts than on the east coast. Grapefruit and seedling oranges appear to be more susceptible to melanose than any other variety of citrus.

The symptoms and the life-history of the fungus are described. The latter lives in the dead twigs and branches of citrus and the spores produced in this situation are the source of the infection of living tissues. The results of inoculation experiments showed that only young and growing tissues are susceptible to the attacks of the fungus, leaves from four to six weeks old being immune. The fruit becomes immune about the end of May or beginning of June.

The results of a series of experiments conducted in 1921 and 1922 showed that spraying with Bordeaux mixture 3–3–50, plus 1 per cent. oil emulsion, gave very satisfactory control of the disease and noticeably improved the appearance of the crop. As the oil emulsion recommended contains 66 per cent. oil it requires 1½ galls. per 100 galls. Bordeaux to make 1 per cent. oil emulsion. [Apparently the object of this addition is to control scale insects and white fly.]

Directions are given for the manufacture of Bordeaux-oil emulsion [see preceding abstract]. All dead wood should be pruned away as far as possible, but it is difficult to secure complete control by this means without spraying, since it is almost impossible to remove all the wood likely to harbour the fungus.

WINSTON (J. R.). **Citrus scab: its cause and control.**—*U.S. Dept. of Agric. Bull.* 118, 35 pp., 16 pl., 6 figs., 1923.

Citrus scab, a parasitic fungous disease second in importance only to the melanose and stem-rot disease caused by *Phomopsis citri*, attacks many species of citrus in India, South China, Japan, Hawaii, Paraguay, Brazil, Central America, Yucatan, the southern United States, Cuba, Porto Rico, and the lesser West Indian islands. It is also reported from the Canary Islands and South Africa. The damage to leaves on bearing trees is slight, but a large percentage of the early dropping of the green fruit is due to fruit scab. Later attacks cause serious blemishes on the fruits and reduce their market value.

In the nurseries the disease is severe, producing a marked stunting effect upon seedling stocks for budding and often reducing growth by 40 or 50 per cent. The average annual loss from scab

to Florida growers is about 1,000,000 boxes, and the cost of production is greatly increased by the necessity of spraying to control the disease. Under Florida conditions the following species are highly susceptible: sour orange (*Citrus aurantium*), lemon (*C. limonia*), calamondin (*C. mitis*), and tangelo (a tangerine-grapefruit hybrid.) The grapefruit and shaddock (*C. grandis*), the King, tangerine, mandarin, and Satsuma oranges, the kid-glove group (*C. nobilis*), and the citrange (a hybrid of *Poncirus trifoliata* and the tangerine) are also susceptible, while sweet oranges (*C. sinensis*) and kumquats (*Fortunella* spp.) are rarely attacked, and the Mexican or Key lime (*C. aurantifolia*) and the Royal and Triumph grapefruits appear to be immune. The Duncan, Walters, Pernambuco, Leonardi, and Foster varieties of grapefruit are all about equally susceptible, Hall (Silver Cluster) being much more so, and Marsh comparatively resistant.

Scab appears on the leaves in the form of minute, circular, raised protuberances, usually on the under surface of the leaf. After a few days the apices of the lesions turn cream-coloured or yellow, and with the expansion of the leaf the lesions become more conspicuous, some forming hollow, conical outgrowths, and others coalescing into flattened scabs. At a later stage the lesions resemble warts and assume a pinkish and finally olivaceous tinge. The functions of moderately infected leaves do not seem to be seriously impaired. On the fruit the outgrowths of the lesions are solid. The protuberances turn from pale yellow to a dusty grey, and on the grapefruit they eventually flatten out, so that the fruit regains its normal shape. On the sour orange and lemon the lesions develop into corky, raised warts. Abnormally early dropping of the fruit or severe blemishes are frequently caused by scab, and even slight blemishes considerably lower the commercial value of the crop. Generally speaking, only the twigs of very susceptible varieties are attacked, infection occurring in the form of cream-coloured (afterwards pinkish and finally grey) warts on the succulent growth of vigorous nursery stock.

The cause of citrus scab was first referred to a fungus of the genus *Cladosporium* by Scribner in 1887. Massee named this fungus '*C. citri* pro tem.' in 1899, and the latter name has come into general use since. The earlier work, however, was erroneous, the fungus observed being a saprophyte unconnected with the disease, though common on the old seeds. The true cause of the latter was isolated by Fawcett in 1906 and erroneously named *Cladosporium citri* Massee, with which, however, it has little in common. What its systematic position really is has not yet been determined, but it has none of the characteristics of *Cladosporium*. The fungus develops well on glycerine agar, colonies being produced on this and on other media in five to eight days at room temperature. The cultures, which form very characteristic, raised, convoluted colonies of a tawny or purplish colour and limited growth, are figured. True conidia are borne very sparingly in culture. In older cultures the convoluted mycelium becomes thick-walled and develops tangled chains of constricted hyphae, which are easily broken apart into chlamydospores. The latter are capable of germination, and probably are the chief source of infection. The optimum temperature for the growth of the fungus was

found to be about 68° F., which may explain the relatively high proportion of infection which occurs during the cool weather of spring. The results of numerous isolation tests showed that when once the scab fungus enters a leaf it can persist there throughout the winter. From cultural data and field observations alike it appears that the disease is seldom or never carried over winter on fruit set in the spring or summer. Examination of the leaf lesions showed that the fungus forms a compact stroma of thick-walled, hyaline hyphae from which numerous sporophore-like stalks arise, but no spores have been found on the latter. The host tissues are penetrated to the depth of a few cell layers, and the affected cells become brown and distorted. Hyperplasia often occurs beneath the invaded area.

The spread of citrus scab is very erratic, the disease sometimes being confined for years to a small group of trees and then suddenly becoming pandemic over large areas. Probably the chlamydospores are responsible for the majority of the primary infections occurring in the early spring, repeated examinations of the lesions having failed to reveal the presence of conidia. In addition to old lesions supplied with a hold-over stroma, many scars occur in which the stromatic mass has weathered away. During the early spring there is a marked flaking off of host and mycelial fragments which may also contribute to the spread of the disease. The relative scarcity of scab in the drier sections of Florida and its absence in California indicate that the fungus is largely dependent on abundant moisture during the period when the leaves are expanding and the fruit is setting. According to Fawcett (*Journ. Agric. Res.*, xxi, 4, p. 243, 1921), natural infection depends also on a temperature range of 61° to 73° F., but the author's investigations indicate that the degree of humidity during the growing season is the more important determining factor. The widespread impression that grapefruit scions on rough-lemon stocks are particularly susceptible to scab is probably due to the fact that such trees produce a much greater vegetative growth during the first few years than is the case with other root systems. There appears to be no scientific foundation for the belief in the immunizing or sensitizing influence of the stock on the scion. There is also no reason to suppose that the virulence of the fungus is on the increase, or that the orange is gradually losing its resistance. The results of an extensive series of inoculation experiments (particulars of which are given) showed that the susceptibility of the grapefruit to scab is greater immediately after the falling of the petals, with a progressive decrease until the fruit reaches a diameter of about three-quarters of an inch. The leaves of all the citrus species tested were most susceptible on emerging from the bud, reaching a stage of immunity when they have developed to half an inch in width. All strains used in the tests appeared to be equally virulent. The fungus remains pathogenic after growing on artificial media for four years. Inoculation experiments on the fruit and leaves of the grapefruit and Satsuma orange with *Cladosporium citri* from old scab scars resulted in a very slight degree of infection.

The results of a series of spraying experiments indicated that Bordeaux mixture, Bordeaux mixture with oil emulsion, and copper

soap gave absolute control of the disease. Burgundy mixture caused a slight russeting of the foliage and lime-sulphur produced serious defoliation. The following spray schedules are recommended for Florida:—I. In orchards where scab is always serious. (1) Just before growth sets in: Bordeaux mixture 3–3–50 plus 1 per cent. oil emulsion. (2) In height of bloom: Bordeaux mixture 3–3–50 plus 0·5 per cent. oil emulsion. (3) A fortnight later: same as (2). (4) A fortnight after (3): same as (1). II. In orchards where scab varies from moderate to serious. As in the foregoing schedule, except that lime-sulphur solution 1 in 40 may be substituted for Bordeaux mixture in the second and third applications. III. In orchards where scab is of minor importance. Three applications of lime-sulphur solution (1 in 30 for the first and 1 in 40 for the subsequent applications). Nurseries can be kept commercially free from scab by occasional applications of Bordeaux mixture plus oil emulsion, and the treatment seems to stimulate the growth of the seedlings. The oil emulsion recommended in this paper is the 'Government formula', namely: 2 galls. paraffin oil, 2 lb. fish oil soap, and 1 gall. water, boiled together.

BALLARD (E.) & NORRIS (DOROTHY). **Bacterial infection of Cotton bolls.**—*Agric. Journ. India*, xviii, 1, pp. 40–49, 1923.

A large proportion of the premature shedding of young bolls of Cambodia cotton (*Gossypium hirsutum*) in South India appears, in the light of preliminary investigations made in 1922, to be due to a bacterial infection which is not *Bacterium malvacearum*; angular spot was not found in the area under observation, though present elsewhere in the Madras Presidency. No fungus was found associated with the early stages of the disease, which always appeared first on the developing seeds, turning them brown and subsequently discolouring the lint and producing a slimy rot within the boll. The exterior of the latter was marked by black, shining spots, and a puncture-like injury could in some cases be noticed right through the boll wall. The organism isolated from affected bolls and considered responsible for the disease is a stout, rod-shaped bacillus, feebly motile, Gram-positive, and non-acid fast; it grows readily on various culture media and produces moist, whitish, translucent colonies on cotton boll extract agar. Preliminary inoculations from cultures gave inconclusive results.

Insect agency appears to play an important part in the dissemination of the disease, although it still remains to be proved whether it is absolutely necessary. So far as any case has been made out, two capsids, *Ragmus morosus* n. sp. and *R. flavomaculatus* n. sp., would appear to be the most likely agents of infection. This point of view is supported by various observations. Boll shedding declined with the partial disappearance of these insects from the field, in spite of the fact that this coincided with a period of strong winds, which are known to be important factors in the distribution of bacterial diseases. The season was very dry, and rain, another possible method of dissemination of the bacteria, could scarcely have played much part. Furthermore, where cotton stainers were not found in the area under observation, only very small bolls were shed with the symptoms described, whereas in another district

where cotton stainers were prevalent the diseased shed bolls were much larger; this difference may well be due to the fact that the capsids are unable to puncture large bolls.

The authors suggest that the disease might possibly be controlled by the use of insecticides, and point out that it may be necessary to find whether the insects suspected of carrying the disease have other plant hosts.

FRIEDERICHS (K.) & BALLY (W.). **Over de parasitische schimmels, die den Koffiebessenboeboek dooden.** [Parasitic fungi which destroy the Coffee berry borer.]—*Mededel. Koffiebessenboeboek-fonds* 6, 147 pp., 5 pl., 2 figs., 1923. (English summary.)

In this paper an account is given of two parasitic fungi capable of destroying the coffee berry borer (*Stephanoderes hampei* Ferr. = *S. coffeae* Haged.). The first has been known for some years in the Dutch East Indies, but without identification. It is always found where the beetle occurs, and is now named *Botrytis stephanoderis* Bally n. sp. The diagnosis of the fungus, pure cultures of which were readily obtained on potato agar and other media, is as follows: mycelium white, clearly septate within the body of the insect, internal hyphae up to 4 μ in diameter, and external ones up to 2 μ. Conidiophores verticillate on branches which are sometimes thickened; conidia 2 to 3 μ in diameter, globose, arising terminally or laterally from small sterigmata. The lateral branches may form secondary or tertiary branches and large heads of conidia are thus developed (as many as 1,000 in one head). In potato cultures stout coremia, simple or branched, and 1 to 2 cm. in height, are formed. *B. stephanoderis* greatly resembles *B. bassiana* in many respects, but differs from the cultures of the latter from the Centraalbureau voor Schimmelcultures examined by the authors in the much larger number of conidia in one head, the presence of coremia, the longer adhesion of the spores, and the yellowish tinge assumed by the cultures in from eight to ten days. In old cultures the conidia remain viable for at least two and a half years.

The second fungus, *Spicaria javanica* Bally n. sp., is much rarer than *B. stephanoderis*, but is equally virulent. It has hitherto been found only on dead beetles in black berries, not in the red or green stages. The diagnosis is as follows: hyphae septate, white, conidiophores profusely branched, length very variable, 1 to 2 μ in width, numerous verticillate branches at the apices. Conidia elliptical, 2 by 1 to 1·5 μ, white, afterwards purple, formed in long chains on secondary branches produced by the primary branches. Smooth antler-shaped coremia, yellow at the base, white at the apex, 1 to 3 cm. in height, developed in potato cultures after three to four weeks. The colour of the fungus on dead beetles is purplish-grey.

Insects destroyed by *B. stephanoderis* obstruct the bore holes with the back part of their bodies, which are covered with the mycelium of the fungus. Days or even weeks may elapse before the dead insects are detected, the mycelium becoming apparent only during rainy weather. The fungus is found chiefly on shaded branches of the bushes. Natural epidemics of sufficient virulence to eradicate the borer do not occur, presumably on account of the

rapid propagation of the insect. It is estimated, however, that the normal number of offspring is diminished by 50 per cent. as a result of the attacks of the fungus.

Inoculation experiments, which are described in detail, with spores from cultures were invariably successful both in the laboratory and in an experimental garden at Malang. Larvae, young and old borers, and other insects, e. g. caterpillars of *Cricula trifenestrata*, were easily infected. A considerable period often elapses before the mycelium develops from the dead insects.

By dusting and spraying spores of *B. stephanoderis* on to coffee berries, and by liberating infected beetles still able to move freely about the plantations, the fungus was introduced into some estates where it had not previously been found. It did not, however, spread any further, probably on account of unfavourable weather.

UPHOF (J. C. T.). **Ueber die Verwendung von Krankheitserregern zur Bekämpfung schädlicher tropischer Insekten.** [The application of pathogenic agents in the control of injurious tropical insects.]—*Tropenpflanzer*, xxvi, 1, pp. 4–7, 1 fig., 1923.

The author, writing from Florida, states that arrangements have been made by the Florida State Plant Board for the cultivation, on a large scale, of entomogenous fungi to check the ravages of scale insects in the citrus plantations. The following fungi are said to be useful against the insects named: *Sphaerostilbe coccophila* for the control of *Lepidosaphes beckii* and *L. gloveri* on citrus fruits, the San José scale (*Aspidiotus perniciosus*) on peaches, plums, and pears, *A. hederae* on *Melia azedarach*, and *Parlatoria pergandei* on citrus. *Microcera fugikuroi* controls *Chrysomphalus aonidum*, *C. aurantii*, and *Lepidosaphes beckii* on citrus. *Ophionectria coccicola* absolutely destroys *L. gloveri*, *L. beckii*, and *Parlatoria pergandei* on citrus. *Aschersonia cubensis* is an extremely useful parasite of various insects occurring on camphor, cinnamon, guava, bananas, mango, &c., including *Toumeyella liriodendri*, *Pulvinaria pyriformis*, and *Eucalymnatus tessellatus*. Pure cultures of *A. cubensis* and other entomogenous fungi will be grown on a commercial scale by the State Plant Board and will be available for distribution at 75 cents each. *A. turbinata* is parasitic on the 'Florida wax scale' (*Ceroplastes floridensis*), *A. aleurodes*, and *Aegerita webberi* on *Dialeurodes citri*, and *Aschersonia flavocitrina* on *D. citri* and *D. citrifolii*.

The importance of entomogenous fungi can easily be demonstrated by spraying citrus trees with Bordeaux mixture, which kills the useful parasites together with other fungi. In a short time scale and other insects, especially the white fly (*Dialeurodes citri*), appear in great numbers.

The fungi flourish during the summer rains or earlier under suitable conditions. *Aegerita webberi* thrives until late in the autumn. Young or neglected orange plantations are not adapted to the cultivation of useful fungi owing to the scarcity of foliage.

During the summer rains the trees should be sprayed with the pure cultures with an ordinary apparatus, the spores of the fungi

being diluted with water and put through a coarse sieve before use. The apparatus must be quite free from copper, to which the fungi are very susceptible.

BRYCE (G.). **Experiments with the green muscardine fungus on rhinoceros beetle larvae.**—*Ceylon Dept. of Agric. Bull.* 65, 7 pp., 1923.

The results of inoculation experiments with two strains of the green muscardine fungus (*Metarrhizium anisopliae*) from the Philippine Islands and Malaya on the larvae of the rhinoceros beetle (*Oryctes rhinoceros*) showed that the fungus was not markedly pathogenic to the insect. This corresponds with Speare's observations on the effect of *M. anisopliae* on the sugar-cane borer beetle (*Exper. Stat. Hawaiian Sugar Plant. Assoc., Path. and Phys. Ser., Bull.* 12, 1912). The incubation period varied from thirty-nine to eighty-one days. Of the two strains, the Philippine made the better growth. The evidence from each experiment indicated that the larvae were only attacked after a considerable period of captivity had diminished their vitality and power of resistance. Apparently healthy larvae, under normal conditions, are not particularly susceptible to the disease, and it is very questionable whether natural infection, to which the beetles are probably subject in Ceylon, since the fungus is known to be indigenous there, could be appreciably increased by artificial means. The method cannot, therefore, be recommended for the control of the rhinoceros beetle on coco-nuts.

BALLINGS (MADELEINE). **Le Vermicularia herbarum parasite des Œillets.** [*Vermicularia herbarum*, parasitic on Carnations.] —*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 288–289, 5 figs., 1922.

A disease observed in the autumn of 1922 at Gagny (Seine-et-Oise) on small-flowered carnations (? *Dianthus caryophyllus*) is stated to be due to *Vermicularia herbarum* (Westend.) Kicks (= *V. dianthi* Westend.).

The plants were not usually killed but were partially defoliated at the base, where the fungus occurred on both stems and leaves. In the middle part of the plant, the leaves only bore small, black dots, formed of sterile fungous tissue, while the top leaves were quite clean. Mature fructifications of the typical *Vermicularia* form were only found at the base of the stem or on old, severely attacked leaves. They bore few conidia. True sclerotia were not seen, but small, compact masses of brown cells are sometimes formed, and possibly play a part in the overwintering of the fungus.

BROWN (NELLIE A.). **Bacterial leaf spot of Geranium in the eastern United States.**—*Journ. Agric. Res.*, xxiii, 5, pp. 361–372, 3 pl., 1923.

A bacterial leaf spot disease of the cultivated geranium (*Pelargonium* spp.) occurs very widely in eastern United States, mostly on greenhouse plants, but occasionally out of doors also. The causal organism, the morphological and cultural characters of which are fully described, was isolated from diseased plants, and inoculation

experiments on healthy geraniums resulted in the typical symptoms of the disease. The organism is regarded as distinct from *Bacterium erodii*, already known to cause a disease of pelargonium leaves, and is named *Bacterium pelargonii* n. sp. Suggestions for control of the disease are given, the chief being the proper regulation of greenhouse conditions and proper spacing of the plants out of doors. Infected leaves should be removed, and very sensitive varieties discarded.

DUCOMET (V.). **Observations sur le développement du Rhizoctone de la Lucerne.** [Notes on the development of the Rhizoctonia disease of Lucerne.]—*Bull. Soc. de Path. Vég. de France*, ix, 4, pp. 312–316, 1922.

The author gives an account of his observations on the violet root rot of Lucerne [*Rhizoctonia violacea*] during many years in south-west France, especially in the Lot-et-Garonne Department.

He states that the disease is favoured by dry conditions, and also by a shallow soil, which permits only a surface root system to develop. The latter factor was responsible for the varying severity of the disease in different parts of an experimental field that has been under observation since 1919. In this field a flat portion consisted of shallow soil overlying fissured calcareous rock, while the adjoining slopes were formed of a deep clay subsoil. The disease was practically confined to the former area, where, however, it was absent from spots in which the soil occupied deeper 'pockets' in the rock. The real cause of the damage in the shallower soils is considered to be insufficient water supply to the roots.

The deaths from the disease are stated to occur chiefly at the beginning of summer and early in autumn. The former period coincides with the onset of dry weather, but the latter is usually wet. It is believed that actual infection of the root by the parasite occurs chiefly during wet periods, and the deaths observed in any one year are probably each the result of an infection contracted during the preceding autumn. If this has made much progress death will result during the dry season at the commencement of the following summer, otherwise the plant survives until a further extension occurs during wet weather later in the year.

If any advantage is to be expected from soil disinfection, as often recommended, the treatment must be given in the autumn, but the author is not hopeful, pending further experiments, of much success in this direction. No evidence has as yet been obtained that it will be possible to select resistant strains of lucerne. Attempts to inoculate strong and well-developed plants have failed, and the parasite, like *Armillaria mellea* and *Ophiobolus cariceti*, is regarded as definitely harmful only to weakly plants.

BENNETT (C. W.). **Apple scab and its control.**—*Quarterly Bull. Michigan Agric. Exper. Stat.*, v, 3, pp. 130–134, 2 figs., 1923.

The season of 1922 was very favourable for the early development and spread of apple scab [*Venturia inaequalis*], a brief popular account of the symptoms and life-history of which is given. A study of the rate of development and discharge of the winter spores under Michigan conditions showed that by 17th April the great

majority of the ascospores which developed in the perithecia on fallen leaves, were ripe and ready for emission during the first rain, which occurred a week later. The spots produced by the first infection were far enough advanced in the next three weeks to form conidia. The danger of early infection is so great in Michigan that the application of a pre-pink spray [see this *Review*, ii, p. 71] cannot be dispensed with.

'Bunchy top' and 'choke throat' in Bananas.—*Queensland Agric. Journ.*, xviii, 5, pp. 368–369, 1922.

In order to check the spread of 'bunchy top' of bananas [see this *Review*, ii, p. 354], the New South Wales agricultural authorities have prohibited the removal of suckers from certain of the Northern River areas. They have also instituted manurial investigations and experiments in dipping. The affected region reaches down towards Byron Bay, and the Brunswick River area is now involved. Plants may not be taken south of a line drawn from east to west south of the Brunswick, and may only be imported from Queensland with the sanction of the Government banana expert. 'Bunchy top' must not be confused with 'choke throat', a contraction of the 'throat' of the banana which prevents the bunch from emerging. This condition is brought about by a protracted spell of drought.

Banana bunchy top disease.—*Queensland Agric. Journ.*, xix, 1, pp. 32–33, 1923.

The results of the investigations on bunchy top of bananas conducted by Darnell-Smith and Tryon in New South Wales have been embodied in a report to the Ministry of Agriculture. The disease has extended from New South Wales into the south-eastern corner of Queensland, where it is causing much loss to growers. The recent research work and field experiments have considerably narrowed the problem by showing that certain theories formerly advanced to explain the disease must be dismissed as untenable.

Field experiments have proved that the use of complete fertilizers of varying constitution, as well as those providing mainly a single essential plant food, do not prevent the occurrence of the disease either in relatively rich or relatively poor soils. The loss of vigour in banana plants by the continuous use of strains of a single origin was also proved not to be an operative factor in bunchy top, which occurred with equal prevalence on plants imported into the affected area from remote districts. Negative results also followed the application of lime or basic phosphates to the soil in order to counteract soil acidity; while the disinfection with various fungicidal preparations of suckers and the soil in which they were planted was equally ineffective in checking the disease.

Investigations have hitherto failed to reveal the presence of fungi capable of originating bunchy top under experimental conditions, though certain organisms, amongst which are some belonging to groups known to contain parasitic forms, have been observed. Further research on these lines is in progress. A nematode has commonly been found in the roots of plants affected with bunchy top, but its presence is not invariable and it cannot, therefore, be the sole cause of the disease. It has been suggested that the

banana aphis (*Pentalonia nervosa*) transmits the disease from one plant to another, or is even possibly the primary cause of bunchy top, but general observations do not support this theory, though field tests based on it are being carried out.

Meteorological factors do not appear to play any considerable part in bunchy top, although a further study of climatic and soil conditions in relation to the disease is necessary before a definite statement to this effect can be made.

CUNNINGHAM (G. H.). **Leaf-curl, bladder-plum, and cherry-curl. Their appearance, cause, and control.**—*New Zealand Journ. of Agric.*, xxvi, 2, pp. 85–97, 7 figs., 1923.

Leaf curl, bladder plum, and cherry curl in New Zealand are caused by *Taphrina* [*Exoascus*] *deformans*, *T.* [*E.*] *pruni*, and *T.* [*E.*] *minor* respectively. The symptoms of these diseases and the life-history of the fungi concerned are described and figured. *E. deformans* attacks peaches, nectarines, almonds, and apricots in New Zealand, being especially severe in seasons of alternating cold and warm weather. Paragon and many other varieties of peach are susceptible, as well as all nectarines. Under New Zealand (Hawke's Bay) conditions Hobbs's Royal, Charlotte, Hales's Early, and Saunders are resistant, but varietal susceptibility differs widely with the locality. Seedling peaches are generally susceptible.

Bladder plum is confined in New Zealand to the plum, the so-called Japanese plums being the most susceptible, though English varieties are occasionally infected. The results of infection include blistered leaves, distorted shoots, dropping of buds, and swollen and hollow fruits.

Cherry curl appears so far to be restricted to isolated orchards in Hawke's Bay and Central Otago, occurring on the Black Tartarian, Early Purple Guigne, and an unknown variety. In Germany the fungus is stated to attack the ground cherry (*Prunus chamaecerasus*) as well as *P. cerasus*, but the latter is the only host known in New Zealand. There seems to be little danger of widespread infection. The symptoms resemble those of leaf curl, but the following points of difference should serve to distinguish the two diseases. Cherry curl attacks only one or two leaves on a branch, and is confined to a limited area covering about one half of the leaf. The leaf tissues and petioles are often curved so that apex and base point in the same direction.

Leaf curl and, to a less extent, bladder plum can be controlled by an application of 5–4–50 Bordeaux mixture or 1 in 15 lime-sulphur when the buds begin to swell. Where leaf curl infection continues to appear throughout the season, spraying should be supplemented by the excision of infected shoots. In bladder plum, and especially in cherry curl, it is always necessary to cut out infected shoots or branches, and this should be done in cherries shortly after growth begins in the spring. Each wounded surface should be at once painted with coal-tar. Bladder plum is only partly controlled by spraying and cherry curl not at all, infection in each case coming from a perennial mycelium in the shoots. Shoots and branches need not be cut back to a greater distance than 2 in. below the point of visible infection, as the mycelia do not readily grow downwards into larger shoots.

WELDON (G. P.). **Spring spraying of Peaches with lime-sulphur.**—*Monthly Bull. Dept. Agric. California*, xii, 1–2, pp. 44–47. 1923.

Experiments in the combined control of leaf curl (*Exoascus deformans*) and the twig borer (*Anarsia lineatella*) of the peach, carried out in California in the spring of 1922 with commercial dry and liquid lime-sulphur, gave excellent results. The experiments are described in detail. A single spraying was given, different plots being treated at different dates. The dry lime-sulphur was stated by the manufacturers to be of such a strength that 2 lb. equalled 1 gall. of the liquid preparation, and was recommended for use dissolved at the rate of 2 lb. to 10 galls. water. The liquid lime-sulphur tested 33° Baumé, and was used at a strength of 1 gall. to 10 galls. water. Both gave practically complete control, and early applications in February were as effective as the later ones in March.

The treatment should be given before the trees bloom, but even when lime-sulphur is applied to peach trees in full flower there is very little risk of injury.

VILLEDIEU (G.) & VILLEDIEU. **Action des oxydes insolubles sur le mildiou de la Pomme de terre (Phytophthora infestans).** [Action of insoluble oxides on the potato mildew (*Phytophthora infestans*).]—*Comptes Rendus Acad. des Sciences*, clxxvi, 8, pp. 534–536, 1923.

In a series of experiments, in which they used conidia of *Phytophthora infestans* and various insoluble metallic oxides (of cadmium, nickel, cobalt, zinc, black oxide of copper, red oxide of mercury, calcined and hydrated magnesium), the authors claim to have established that the latter are toxic to the fungus to the extent that they inhibit the germination of the spores. The insoluble or slightly soluble oxides were placed in twice distilled water for at least 24 hours, with frequent stirring, and the water filtered off in one series, while in another the oxide was left suspended in a finely powdered form in the water. In the former the spores germinated normally, and gave active zoospores. In the latter the few zoospores that escaped were immediately killed. Further experiments showed that killing only took place in the immediate vicinity of the solid particles. This toxicity is considered to be connected, in part at least, with the basic function of the oxides used, since a number of others tested had no such action, and besides, by reducing the oxides to salts by the addition of mineral or organic acids, their toxicity was very considerably diminished.

BRYCE (G.). **The toxicity of lime to Fomes lignosus Klotzsch.**—*Ceylon Dept. of Agric. Bull.* 64, 17 pp., 1923.

The application of quicklime to infected soil for the control of *Fomes lignosus*, which causes considerable damage to the roots of *Hevea brasiliensis* in Ceylon and elsewhere, is fairly general. After the removal of the diseased trees the quicklime is forked into the soil or scattered over the surface at the rate of about 60 lb. per tree. The effect of the lime on the fungus may be two-fold: (1) scorching caused by direct contact; (2) toxicity produced by the slaked lime in solution or by the alkalinity induced in the soil.

Quicklime having occasionally proved ineffective in the field, cultural experiments were carried out in order to obtain information as to the growth of the fungus under acid and alkaline conditions, and to investigate the action of quicklime on its development.

Pure cultures were obtained from a young fructification and sub-cultured on a neutralized medium, as required, during the remainder of the experiment. The fungus grew best on French bean agar, forming a thick, felted mycelium interspersed with strands; on maize and potato the growth was somewhat thinner. Particulars are given of the titration of the media and the preparation of the acid, alkaline, and control series of cultures. The following substances, namely, hydrochloric acid, sulphuric acid, citric acid, caustic soda, and caustic potash, were added to the media in the toxicity series, in different concentrations, obtained by adding varying quantities, by volume, of normal solution to 12 cc. of medium. Lime was added as slaked lime in weighed quantities and as concentrated lime water solution.

The results of the experiments, which are described in detail, showed that the fungus is capable of growth on media up to −66 Fuller's scale, while it develops with difficulty at +8, and is totally inhibited at +16 of the same scale. At −8 Fuller's scale growth was generally equal to that on the neutral control dishes. The fungus, therefore, is capable of growth under a wider range of alkaline than of acid conditions. With slaked lime total inhibition of growth occurred at a concentration of about 0·15 gm. per 11·25 gm. of medium, or 1·33 per cent. of slaked lime. Taking the top 8 in. of soil as weighing 2,000,000 lb. per acre, and the area occupied by one tree as 480 sq. ft., the weight of the top 8 inches of soil round one tree is 22,000 lb. To obtain a concentration of 1·3 per cent. of slaked lime in this quantity of soil the amount required for each tree would be 292 lb., or roughly five times the quantity usually applied.

The fungicidal effect of burnt lime on *Fomes lignosus* mycelium depends on the caustic action of caustic lime in direct contact with the mycelium, and on the degree of alkalinity subsequently produced in the soil. The proportion of caustic lime in Ceylon burnt coral lime is only 25 per cent., as against 80 to 90 per cent. in good European burnt lime. Hence the corresponding lower fungicidal value of the Ceylon product. Carbonate of lime has no deterrent effect on the growth of the fungus. Recent soil studies demonstrate that, under Ceylon conditions, the quicklime applied to the soil is rapidly converted into carbonate. Its effects on the mycelium of *F. lignosus*, therefore, are purely ephemeral, and its application, pending further investigations, cannot be recommended.

PARKER (T.) & LONG (A. W.). **Spray spreading agents.**—*Bull. Bureau Bio-Technology* (Murphy & Son, Ltd., Sheen Lane, London), 8, pp. 252-258, 10 figs., 1923.

In this paper various experiments are described the aim of which was to determine the value of calcium caseinate as a spray spreader.

In the first experiment, two clean sheets of glass were sprayed, one with lime-sulphur 1 in 20 and the other with a similar solution to which 0·2 per cent. of calcium caseinate had been added. The

plates were allowed to drain and photographs of them show the deposit from the former solution in patches, whereas that from the latter is evenly distributed.

Similar experiments with ammonium polysulphide 1 in 100, arsenate of lead 4 lb. to 100 galls., and liver of sulphur and nicotine petroleum emulsion gave similar results.

Dried films from lime-sulphur, ammonium polysulphide, liver of sulphur, and lead arsenate solutions with and without the addition of 0·2 per cent. calcium caseinate were examined microscopically, and it was observed that the particles deposited from solutions with the spreader were much closer together than those from solutions without. The former therefore would probably have a greater fungicidal efficiency.

An experiment was carried out to ascertain the effect of calcium caseinate over the rate of settling of a suspension of lead arsenate. The latter (4 lb. to 100 galls.) was placed in one cylinder, and a similar suspension, with calcium caseinate added, in another, the cylinders being shaken simultaneously for one minute before being allowed to settle. Photographs taken at intervals show in the former case evidence of sedimentation in five minutes, whilst after fifteen minutes settling was nearly finished, and in an hour it was complete: in the latter case the arsenate still showed excellent suspension six hours later. The addition of calcium caseinate to lead arsenate therefore obviates the necessity for very elaborate stirring gear in the spraying machine.

A number of experiments were carried out to test the spreading power on plants of solutions with and without the addition of calcium caseinate. Foliage having a polished and smooth surface (e. g. ivy, apple) yielded results similar to those on plate glass, whilst on leaves with spines (e. g. hop, marrow) the fluid either with or without the spreader appeared to collect in globules on the apex of the spines, and on leaves with a waxy bloom (e. g. carnation, savoy, cabbage) the spreader had little effect in increasing the spreading.

Further experimental work is stated to have shown that apple scab [*Venturia inaequalis*] and American gooseberry mildew [*Sphaerotheca mors-uvae*] can be controlled with lime-sulphur, 1 in 160, used in conjunction with calcium caseinate, without defoliation or russeting.

ADAMS (J. F.). **Improving our orchard sprays with a fixative.**—Reprinted from *Trans. Peninsular Hort. Soc., 1923,* pp. 1–8. 1923.

In a somewhat detailed historical summary of the development of the use of spreaders from 1885 onwards, the author, following Moore, first points out that 'spreading' refers to the formation, or maintenance after being formed, of a continuous film over the surface of the leaf, whilst 'adherence' applies to the resistance of the dried spray deposit to weathering. 'Wetting' is the slight chemical or physical affinity between the liquid and solid, and is one of the factors producing a continuous film.

Of recent years much attention has been given to the possibility of using casein as a spreader. This substance is colloidal in

character, and combines with certain other substances to form agglutinant compounds which are very stable and extremely resistant to moisture and atmospheric changes.

In order to obtain a preparation in liquid form and one thereby easier to use, experiments were made to bring the casein into solution. Casein is soluble in an alkaline solution, but the process is slow when lime is used, and the proportion of lime necessary increases the volume of the resultant mixture. Sal soda was found to be the most economical of the efficient substances tried and a stock solution of the following composition was adopted. Casein 5 lb., sal soda 1 lb., water 10 galls. [American]. The sal soda is added to the water, which is then gradually heated and the casein added slowly during heating. The latter should become dissolved in about 10 minutes, boiling being unnecessary. This stock solution should be of a slimy, sticky consistency, and should be used at the rate of 2 qts. per 200 galls. of diluted spray solution, producing a foam on the surface of the latter after thorough mixing. The casein solution imparts to the spray both spreading and adhesive properties, and the author therefore applies the term 'fixative' to it.

A series of experiments was made to determine the quantity of arsenic in the deposit of an arsenic spray with and without the casein 'fixative'. The increase of arsenic adhering to the leaves when the latter was used amounted to 20 per cent. over the control.

Trials with the fixative on a commercial scale with B.T.S., atomic sulphur, lime-sulphur, and Bordeaux mixture were carried out with very satisfactory results.

Cook (M. T.). **The origin and structure of plant galls.**—*Science*, N.S., lvii, 1462, pp. 6-14, 1923.

The author considers that the study of the pathological histology of plants has been greatly neglected, especially in America. Workers on the various groups of galls caused respectively by insects, fungi, nematodes, and bacteria, have generally known little of the studies pursued by investigators in the other groups. The results of these studies require to be correlated in order to serve as a basis for future research in this important branch of botany.

One of the earliest problems which arose in connexion with plant galls was the nature of the irritant, and this has not yet been fully solved. In the case of both insect and nematode galls it is uncertain whether the stimulus which induced their formation is mechanical or chemical, and the same seems to be true of galls caused by fungi. The slime mould *Plasmodiophora brassicæ* penetrates the cells, causing enlargement and division not only of the cells with which it comes into direct contact, but also of those in the vicinity. The latter are apparently stimulated by the passage of some substance from the diseased cells. Oedemas are well known to result from chemical irritation, while calluses and the like are frequently due to mechanical causes. Many insect galls are now believed to be the result of purely mechanical stimuli.

Galls caused by bacteria may be divided into three groups: (*a*) the olive knot group [*Pseudomonas savastanoi*], in which the bacteria occupy small pockets and stimulate the surrounding cells; (*b*) the legume nodule group, in which the bacteria are within the

cells; (*c*) the crown gall group, where the position of the bacteria does not seem to be well understood.

There are three well defined stages in the formation of plant galls: (1) cell enlargement or cell division or both; (2) the failure of the affected part to differentiate into the characteristic tissues of the normal plant organ on which the gall is formed; (3) the differentiation into the characteristic tissues of the gall. Küster has classified galls into two comprehensive groups: (1) kataplasmas or those in which the structure is undifferentiated parenchyma and (2) prosoplasmas in which there is a differentiation into other tissues. The galls of *P. brassicae* on the Cruciferae are true kataplasmas, intumescences are very simple kataplasmas, and bacterial and fungous galls include kataplasmas and simple prosoplasmas.

Insect galls all originate from the meristematic cells and are at first true kataplasmas, but many of them pass into the prosoplasma stage in which fibrous and sclerenchymatous tissues are more or less prominent. The writer's researches have consistently indicated that insect galls always originate during early periods of very active development in the life of the plant. In nematode galls the point of excitation is less definite than in the insect galls, and the form and character of the abnormality vary according to the age of the root and the number of individuals attacking it.

Some of the fungous galls are kataplasmas, while others are prosoplasmas of varying degrees of complexity. In all cases the direct modifications are mainly in the parenchyma tissues. Study of the galls caused by the cedar and apple rust fungi have led to very divergent conclusions. Stewart believes that galls of *Gymnosporangium juniperi-virginianae* arise from axillary buds, and that each gall contains two fibro-vascular systems, one derived from the incipient stem and the other from the leaves; the parenchyma tissues predominate, and the fibro-vascular structures are dwarfed and modified. He finds practically the same condition in the galls of *G. globosum*. Reed and Crabill believe that the galls arise from the leaf, and their descriptions indicate that in origin and structure these galls are similar to those caused by the Cynipidae on oaks and roses. The author has studied a number of other plant galls due to fungi and found them to conform quite well in origin, structure, and development to insect galls in general.

The galls caused by *P. brassicae* have been closely studied of recent years by Lutman, Chupp, and Kunkel. They are true kataplasmas, and it is evident that the cortex of the host reacts to the organism, that the cambium is specially susceptible, and that the cells of the medullary rays also respond to the stimulus. The distortions of the xylem appear to be due to the force exerted by the infected rays and other parts. The action of the organism on the cambium tends to prevent the formation of vascular elements.

Bacterial galls must be classed as kataplasmas, or in some instances as very low forms of prosoplasmas. The legume nodules due to *Bacterium radicicola* and the olive knot also appear to originate in the cambium, and are true kataplasmas. Recent studies on crown gall indicate that all meristematic cells react to *B. tumefaciens*, but the character of the galls depends largely on the activity of the cells at the time of infection. The author believes

that the xylem seldom, if ever, reacts to stimulation by *B. tumefaciens*, though the sheath cells may do so. The most complex and definite galls in this case arise from the cambium, the simpler ones from other meristematic tissues. The development of rather weak fibrous tissues in the galls indicates that the crown gall is a low type of prosoplasma. It agrees very generally in origin, development, and mature structure with other plant galls regardless of the causal organism. There are, however, three marked differences between some of the bacterial and the other galls, namely, (1) the presence of the tumour strands in crown gall; (2) the more prolonged or more variable stimuli of bacterial galls; (3) the formation of embryomas or tumours containing leaf shoots or roots attributed to crown gall. The first appears to be a well defined feature of crown gall, but not of other types of bacterial galls: the second and third are still open to question.

In answer to the author's queries, Dr. E. F. Smith defined embryomas as 'crown galls containing aborted shoots, often in great numbers', and differing from the aerial tubers on potatoes caused by *Rhizoctonia solani* in their adventitious character. He also stated that the shoots resulting from inoculation with *B. tumefaciens* do not differ from shoots arising as a result of other injuries, except that the tumour tissues mingle with them, causing injury and abortion. Levine, working with crown gall on *Bryophyllum calycinum*, states, however, that *B. tumefaciens* does not cause the formation of the leafy shoots, but inhibits and retards normal development; the formation of the leafy shoots is mechanical and secondary to that of the gall. The production of buds where they do not normally occur has been reported by Woronin, Favorsi, and Kunkel in *Plasmodiophora brassicae* infections.

The fungous, slime mould, and bacterial galls differ from the more highly developed insect galls in the absence of any well defined cessation of cell activity such as results in the latter case when the larva reaches maturity.

The researches of Wells confirm the author's view that all galls originate with the excessive development of parenchyma tissue. Accepting Küster's groupings into kataplasmas and prosoplasmas, Wells points out that the latter have arisen by evolutionary processes. Kataplasmic evolution is the result of progressive inhibition of differentiation ending with tissue homogeneity. Prosoplasmic evolution begins when homogeneity has been attained and is the development of new tissue characters.

The author concludes that all galls originate in practically the same manner whatever the stimulus which excites their growth may be. The latter must be applied to meristematic tissues, but in all cases it appears that it may extend beyond the point occupied by the causal organism. In most cases the stimulus is probably due to an excretion by the organism and the reaction of cells to the stimulus is remarkably similar whatever the nature of the latter.

BUTLER (E. J.). **Some characteristics of the virus diseases of plants.**—*Science Progress*, xvii, 67, pp. 416-431, 1923.

In this paper the information at present available on the virus diseases of plants is summarized and discussed. Four main groups

are distinguished: mosaic, infectious chlorosis, phloem necrosis, and the peach yellows type, the last two being regarded as allied. The work of various investigators is outlined and the symptoms of the diseases described. An account is given of the different methods of transmission, the passage of the virus within the plant, and the properties of the virus. The influence of environmental factors, including temperature, soil, fertilizers, and light, is briefly discussed, and the paper concludes with some general observations on the nature of the diseases, their economic importance, and the analogy between them and certain diseases of animals and man.

COLEMAN (L. C.). **The transmission of Sandal spike.**—*Indian Forester*, xlix, 1, pp. 6–9, 3 pl., 1923.

The author has shown in a previous paper (*Dept. Agric. Mysore, Mycol. Ser., Bull.* 3, 1917) that sandal spike can be transmitted by means of grafting, this being the only method of transmission hitherto established. It is obvious, however, that in nature the disease must be transmitted in some other way, either through the roots or through the aerial portions of the tree. The fact that sandal trees readily form haustorial connexions with the roots of sandal as well as of other trees suggested the probability of root transmission, and an experiment was therefore carried out to settle the question.

During 1916 a number of seedling sandal trees were transplanted in groups of two or three in common pits in the laboratory compound and left to grow till June 1921 to ensure the development of a good root system and the formation of haustorial connexions. On 11th June 1921, one of the seedlings in several of these groups was grafted with bits of branches from a diseased tree. In the case reported in detail the scion grew, producing the typically spiked leaves of the stage shown by the tree from which it was taken. On 1st July 1922, the disease was first observed breaking out simultaneously on all parts of the adjacent tree in the pit. This phenomenon differed completely from that produced by grafting, when the disease spreads gradually from branch to branch. Two months later the roots of the two trees were examined and three haustorial connexions were established, two belonging to the ungrafted and one to the grafted tree. The haustoria were alive and apparently functioning. Many other haustoria were unearthed, some forming connexions between two roots of the same tree, and others being attached to the roots of an adjacent cork tree (*Millingtonia hortensis*).

It is important to note that two of the above-described haustorial connexions were of the ungrafted tree on the grafted one. The infective virus or ultramicroscopic organism could readily be taken up by these haustoria and carried into the previously healthy tree along with the sap stream. Probably, however, any organic connexion from grafted to ungrafted or vice versa would lead to infection.

The result of this experiment, which is supported by two other similar cases in which the roots have not yet been exposed, proves conclusively that spike disease is transmissible through the haustoria, and at the same time disposes of the theory of an external

cause of infection. In the area in which the experiment was conducted there were at least one hundred sandal trees, and not a single case of spike has occurred except those brought about artificially by grafting or haustorial infection as described above.

It is highly improbable that the natural transmission of spike disease occurs only through the haustoria. New diseases of the same general type have recently been discovered in large numbers and in many cases insects have been definitely proved to be responsible for their transmission from infected to healthy plants. Experiments will be undertaken to ascertain whether insects are concerned in the transmission of spike disease.

BRANDES (E. W.). **Mechanics of inoculation with Sugar-cane mosaic by insect vectors.**—*Journ. Agric. Res.*, xxiii, 4, pp. 279–283, 2 pl., 1923.

A study of the results of experiments conducted in the United States, Java, Cuba, Hawaii, and Porto Rico, affords conclusive proof that *Aphis maidis* is capable of transmitting mosaic disease of sugar-cane. Evidence has further been adduced which indicates that *Peregrinus maidis* and possibly *Carolinaia* sp. may also act as agents of transmission.

The results of recent experiments carried out by the author demonstrated that with *A. maidis* the beak is usually placed on the thinnest point of the cuticle covering a stomatal guard cell, and the setae are then thrust into the cuticle by pressure. A copious secretion is poured out at the end of the setae from the salivary glands, and continues to exude from the tips of the setae as they pass into the deeper tissues, forming the sheath described by Büsgen in his work on aphids and honey dew in 1891. The setae of *A. maidis* pass through the sub-stomatal cavity, then either inter- or intracellularly through the mesophyll cells, continuing between two cells of the starch sheath and finally into the phloem of the vascular bundle. During the entire process, the copious secretion from the insect pours into the rapidly-growing tissues of the leaf, which remain practically intact. The fact that the setae reach to the phloem cells, rich in substances of nutritive value for micro-organisms, seems specially significant. In the writer's opinion, the secretion above mentioned is unquestionably the medium whereby the infective principle of mosaic is carried into the plant. A more perfect mechanism for inoculation could scarcely be devised. There is no apparent wound reaction on the part of the plant; at any rate, none could be seen in the phloem.

Sections of the leafhoppers, *Peregrinus maidis* and *Draeculacephala mollipes*, point to the tracheae rather than the phloem as the object of attack with these forms. It would appear possible for the latter insect to penetrate to the vascular bundles by mechanical pressure alone, instead of by the digesting action of saliva, which appears to be necessary for the process in the case of *A. maidis*.

SALMON (E. S.). **'Mosaic' disease of Hops.**—*Journ. Min. Agric.*, xxix, 10, pp. 927–934, 3 figs., 1922.

An obscure disease of hops, somewhat resembling, but distinct from the 'nettlehead' or 'eelworm' disease is stated to belong to

the mosaic or 'virus' group of plant diseases, and it is suspected that the 'nettlehead' disease also belongs to this group and is not caused by eelworms.

In the mosaic disease described in the present paper, the plant is usually infected for some time before the symptoms become noticeable. The stems ('bines') have shortened joints, are unable to climb, and grow to a height of only four to six feet from the ground. The leaves are somewhat curled with recurved margins (not incurved, as in nettlehead), more or less mottled green and yellow, and, together with the upper part of the stem, markedly brittle. All such affected bines remain sterile. The diseased shoots may remain green throughout the season or die off during the summer; the roots on examination are found to be partly dead. Less frequently—possibly in cases of recent infection—the bine attains a normal height and produces a varying amount of hops, but symptoms of disease are apparent in the curling and mottling of the leaves, especially of the lateral branches, and in certain characteristic malformations of the hop-cones. In the commercial hop-gardens this relatively mild form of the disease is probably overlooked, with the result that the disease is spread by cuttings taken from such hills. In rare instances the tips of the bines and lateral branches die back for a certain distance.

The disease has been under observation for some years past both at Wye and at the East Malling Research Station, and all the available evidence shows that the infection is frequently spread by means of cuttings taken from affected plants at a time when the latter were apparently healthy. Details of several cases are given in which the disease, in a latent form, was carried in cuttings taken from apparently normal plants.

Attempts to control the disease by the early pulling of shoots from affected hills, in the hope that the shoots arising later would be healthy, gave negative results except in a very few instances. The full control of the disease cannot be achieved until its exact cause and the manner of infection are known, but in the meantime the following measures may be recommended. (1) Immediate grubbing up of affected hills. (It is believed that green-flies (aphids) and possibly other insects transmit the disease from infected to healthy plants). (2) The careful inspection of adjoining hills for the detection of the first signs of the disease. During June and immediately before picking a systematic examination of the gardens should be made. (3) Cuttings should, if possible, not be taken at all from any garden affected with mosaic disease; if this course is impracticable they must not, on any account, be taken from the hills contiguous to one which has been grubbed up.

LUNDEGÅRDH (H.). **Die Bedeutung des Kohlensäuregehalts und der Wasserstoffionkonzentration des Bodens für die Entstehung der Fusariosen.** [The importance of the carbonic acid content and hydrogen-ion concentration of the soil in the origination of *Fusarium* diseases.]—*Bot. Notiser*, 1923, 1, pp. 25–52, 4 figs. 1923.

The results of a series of experiments carried out in 1922 showed that a concentration of carbonic acid exceeding 1 per cent. in the

soil delayed the germination and development of wheat seedlings. The addition of 3 to 5 per cent. of CO_2 resulted in a reduction of germination exceeding 50 per cent. There was no trace of the alleged stimulating effect of carbonic acid observed by previous investigators. Corresponding tests with three species of *Fusarium* (*F. avenaceum*, *F. culmorum*, *F. herbarum*) and *Gibberella saubinetii* indicated that high concentrations of CO_2 (3 to 7 per cent.) not only exerted no retarding influence on mycelial growth, but actually stimulated it in two cases (*G. saubinetii* and *F. culmorum*). Thus it is evident that the fungi in question can thrive in conditions which adversely affect the development of seedlings. This fact may give a useful clue to the cause of the prevalence of fungous attacks in impermeable soils.

The infection of growing seedlings by the fungi in question was favoured by the presence of 2 to 8 per cent. of carbonic acid in the air. In every case the seedlings were reduced to an enfeebled condition by the carbonic acid. Under natural conditions the seedlings are exposed to the soil atmosphere during the first few days, and if this is rich in CO_2 a somewhat similar effect would be produced. The attacks of *G. saubinetii* and *F. avenaceum* were very virulent under such conditions, the affected plants showing the typical symptoms of wilting, namely, a brown discoloration of the base of the stem and a stoppage in the flow of water through the vessels. The disease was progressive, more plants showing evident symptoms of attack after 30 than after 9 to 12 days. The CO_2 treatment ceased after 9 to 12 days, so that the later development of the disease indicated that once infection has been promoted the subsequent growth of the parasite within the host tissues is not dependent on CO_2 to the same degree. In certain cases, however, the infected plants outgrew the infection and developed normally, another typical feature of foot rot of wheat under natural conditions.

The injurious influence of impermeability of the soil may be due not only to excess of carbonic acid but also to a deficiency of oxygen. The latter must be very pronounced, however, to produce any noteworthy effect, as cereals and other economic plants germinate normally at one-fifth to one-tenth of the normal oxygen pressure. The likelihood of such a shortage of oxygen in ordinary cultivated soils is negligible, and the arrested development of the seedlings used in the experiments may safely be attributed to the high proportion of carbonic acid.

Experiments were also carried out with hydrogen-ion concentrations ranging from 2·7 to 8·4, within which limits the four species referred to above were capable of growth. The germination of wheat was lessened at P_H 5·5 to 5·9, on each side of which the germination curve rose to about P_H 5 and P_H 7 respectively. At P_H 2·7 to 3·0 development of the fungi proceeded very slowly. Morphological differences were also noticeable in the fungus cultures; at high concentrations several distinct colonies were formed, while an alkaline reaction produced only a single, thin, hyphal membrane. The results of the author's tests with *G. saubinetii* confirmed those obtained by Hopkins [see this *Review*, i, p. 340], the growth curve showing a minimum at about P_H 5·6, on each side of which it rose

in approximately the same manner as in the wheat germination curve. All the species showed a definite tendency to develop a slightly alkaline reaction in the culture medium. *G. saubinetii* and *F. avenaceum* exhibited this character most strongly, which may account for their capacity to flourish in almost all soils and to withstand the acidity in the sap of their host plants.

It has frequently been observed that plentiful fertilization with organic manure, especially in a fresh condition or too late in the season, favours the development and spread of infectious diseases. On the results of these researches the author attributes this to the fact that, even in moderate quantities, such manure increases the CO_2 content of the soil, with the consequences described above.

PRIESTLEY (J. H.) & WOFFENDEN (LETTICE M.). **The healing of wounds in Potato tubers and their propagation by cut sets.**—*Ann. of Appl. Biol.*, x, 1, pp. 96–115, 3 figs., 1923.

When the cut surface of a potato tuber is exposed to air, the sequence of events during the healing process is as follows, the colour changes, which are of no direct significance, being omitted. The first step is the deposit of a fatty 'suberin' layer, formed by the oxidation and condensation of the fatty substances from the sap, along every wall of every cell at a certain depth below the cut surface. Oxygen seems to be essential to the formation of this layer, which develops within twenty-four to forty-eight hours and is continuous if the cut surface is exposed in a moist atmosphere, but is broken when the air is dry, and particularly when the cut surface is exposed to sunlight. When cut tubers are lost owing to fungous attacks the loss can often be traced to exposure to dry air or the sun after cutting, with consequent inefficiency of the protective suberin layer.

A few days later cork is formed below the suberin deposit, as the result of cell divisions in an active cork phellogen. This activity appears to be promoted by the accumulation behind the surface blocked by the suberin layer of sap-containing substances diffusing from the vascular bundles, and by the production of an acid reaction just below the blocked surface through the anaerobic conversion of sugars into fatty acids. The activity of the cork phellogen, which is roughly estimated by the number of cork layers produced, differs with the variety of potato, and tests have shown that Majestic, King Edward VII, and Bishop are particularly lacking in this respect. The results of the authors' tests bring out the undesirability of cutting potato setts in sunlight or exposing them to an exceedingly dry atmosphere before planting, and the advantage of an interval of one or two days between cutting and planting. The practice of treating cut setts either with slaked or caustic lime does not appear to serve any useful purpose, at least so far as it influences the healing of the wound.